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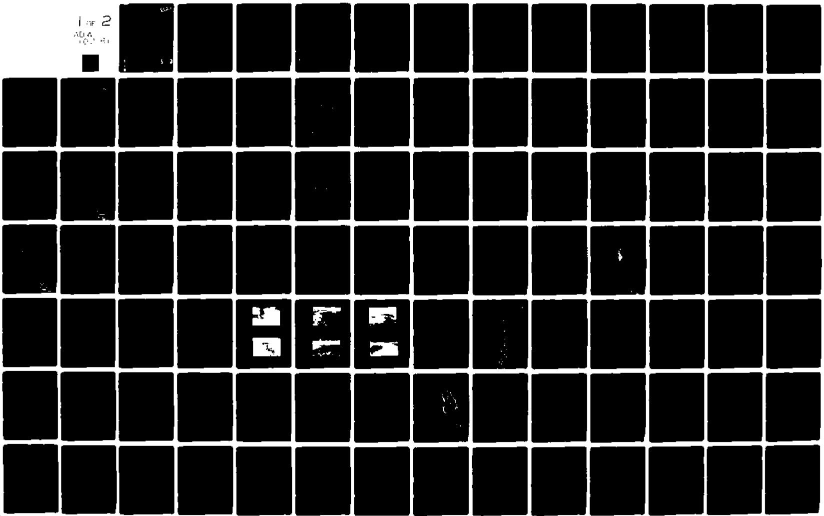

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CUYAHOGA RIVER, OHIO
RESTORATION STUDY

THIRD INTERIM PRELIMINARY FEASIBILITY REPORT ON EROSION AND SEDIMENTATION

VOLUME I - MAIN REPORT

U.S. ARMY CORPS OF ENGINEERS, BUFFALO DISTRICT
1776 NIAGARA STREET
BUFFALO, NEW YORK 14207

November 1979
(Revised April 1981)

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A102	3. RECIPIENT'S CATALOG NUMBER 181
4. TITLE (and Subtitle) Cuyahoga River, Ohio Restoration Study. Third Interim Preliminary Feasibility Report on Erosion and Sedimentation. Volume I & II		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, Buffalo 1776 Niagara Street Buffalo, New York 14207		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, Buffalo 1776 Niagara Street Buffalo, New York 14207		12. REPORT DATE Nov 1979 (revised April 1981)
		13. NUMBER OF PAGES 120,340
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Cuyahoga River

Restoration Study

Erosion

Sedimentation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of this appendix is to identify the sources of sediment in the Cuyahoga River Basin between Independence, Ohio (river mile 13.8) and old Portage, Ohio (river mile 40.25). The sediment entering the river system is derived from erosion of the streambanks and the upland area. The highly erodible principal soil types are composed of silts and sands. Geologic, climatic, and hydrologic factors affect the rate at which soil erosion occurs. For example, soils with steep slopes that are unprotected by vegetative cover erode faster

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) than those on flatter slopes. Erosion is also greater for areas with high annual precipitation and long, cold winters, where vegetation is either dormant or destroyed. The Cuyahoga RiverBasin historically has had serious erosion and sedimentation as displayed by onsite physical evidence, complaints, and various attempts of remedical actions by local interests. The problem is demonstrated by the naming of the Cuyahoga demonstrated by the naming of the Cuyahoga River which is derived from Indian words meaning "Grooked River", and the original settler naming of the tributary streams in the area such as Mud Brook, Sand Run, and Yellow Creek.

CUYAHOGA RIVER, OHIO
RESTORATION STUDY
THIRD INTERIM PRELIMINARY
FEASIBILITY REPORT
ON
EROSION AND SEDIMENTATION

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ACKNOWLEDGMENTS

Many individuals, both in the Buffalo District of the Corps of Engineers and from other agencies at various levels of Government, were involved in the studies culminating in this Third Interim Preliminary Feasibility Report on Erosion and Sedimentation. Primary study team personnel of the Buffalo District who contributed significantly to the study and report preparation are:

Richard Aguglia - Project Manager, Western Basin
John Zorich - Chief, Western Basin
Michael Pryor - Geologist
Paul Lang - Biologist
Mary Jo Braun - Social Scientist
Robert Klips - Biologist
Joseph Kurek - Chief Estimator

Special recognition is given to the many staff personnel of the Soil Conservation Service (U.S. Department of Agriculture) in the State Office at Columbus, OH, the Area Office at Medina, OH, and the Midwest Technical Service Center at Lincoln, NB, who performed the majority of the technical work associated with data collection and interpretation, preliminary designs and cost estimates and text preparation for Appendices A and C. Personnel who contributed significantly to the study are:

Robert R. Shaw - State Conservationist
David Kile - Assistant State Conservationist
Harvey Kananen - Soil Conservationist, (CRRS Project Coordinator)
David Samples - Civil Engineer
Jim Steiner - Soil Conservationist whose untimely passing will long be remembered by those associated with him.
Donald Pettit - Soil Conservationist
Nathaniel Wilder - Soil Conservationist
Don C. Buckloh - Area Conservationist
George Stem - Resource Conservationist
Donald Urban - Resource Conservationist
Bonnie Lee - Area Clerk

A very significant contribution was made by the U.S. Geological Survey in Columbus, OH, and particularly the following personnel:

David Click - District Chief
Jessie Klingler - Hydrologic Technician
James Board - Hydrologist

Other agencies have contributed to this report through the preparation of supplemental reports, report material and participation in agency workshops. The individuals involved are numerous and not easily identified. Therefore, recognition is provided by the names of their employing agencies as follows:

U.S. Fish and Wildlife Service, Columbus, OH, Field Office
Ohio Department of Natural Resources

National Park Service, Cuyahoga Valley National Recreation Area
Northeast Ohio Areawide Coordinating Agency
Three Rivers Watershed District

The report itself was produced through the efforts of many other Corps personnel, including the following who contributed significantly to its preparation:

Roman Bartz - Chief, Drafting Section
John Acker - Drafting Section
Freda Soper - Chief, Word Processing Center
Lillian Stryczek - Word Processing Center
Linda Jones - Word Processing Center
Shirley Kessler - Word Processing Center
Mary Ann Schultz - Word Processing Center
Margaret Friedman - Word Processing Center
Wilbert Binga - Chief, Reproduction Section

The Buffalo District Engineer during the final phase of this Preliminary Feasibility Report was Colonel George P. Johnson, the Chief of the Engineering Division was Donald M. Liddell, and Charles E. Gilbert was Chief of the Planning Branch.

Finally, the efforts of other individuals who participated in the study and report preparation but whose names have not been mentioned above, are gratefully acknowledged.

SECTION A
INTRODUCTION

The purpose of this section is to introduce the reader to the Cuyahoga River Restoration Study - Third Interim Report on Erosion and Sedimentation and to explain the content and organization of this report. The section presents information on the geographical setting of the study area; the study authority; the purpose of the study; the scope of the study; study participants and coordination; the organization of the report; and prior studies and reports in the area.

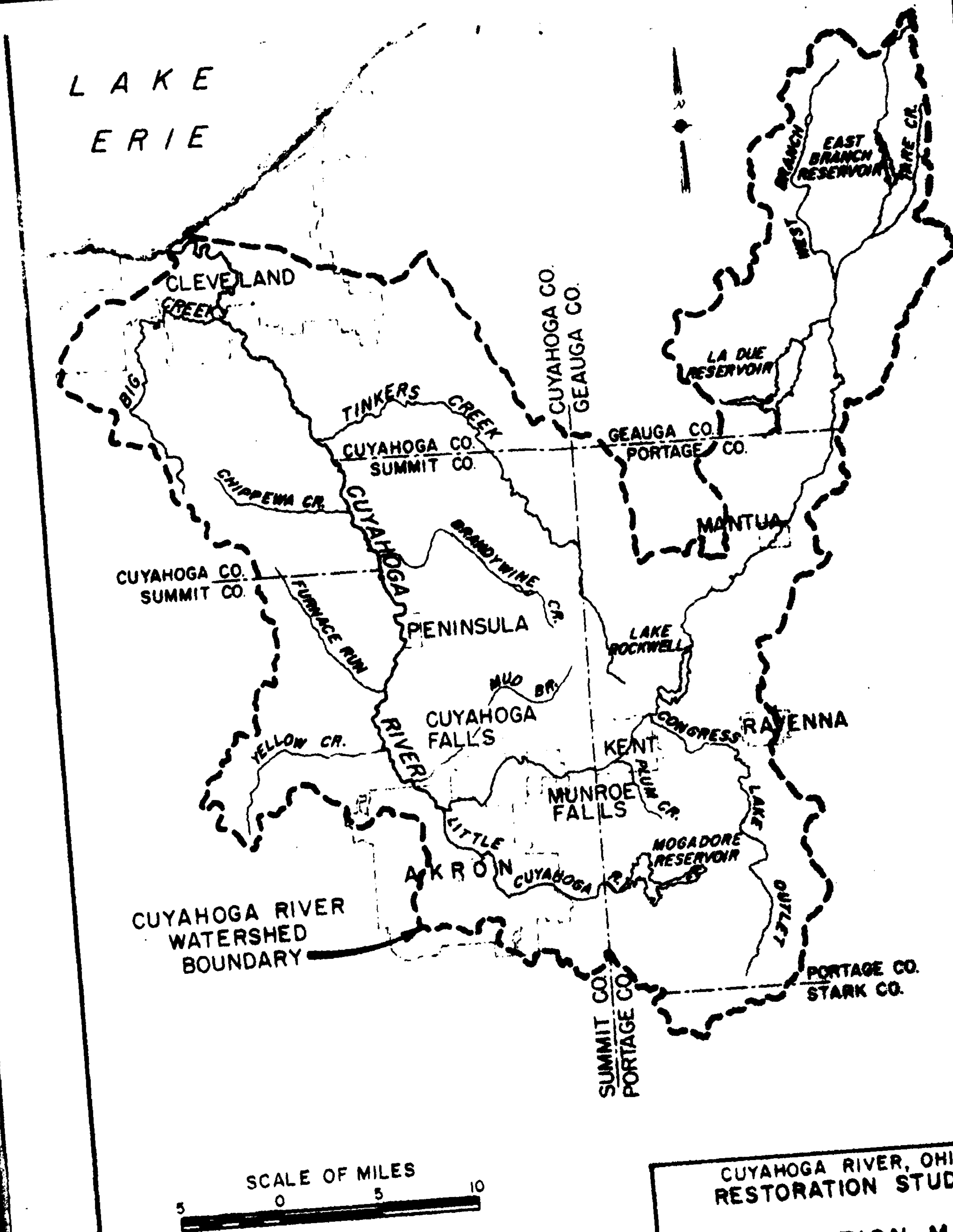
1. GEOGRAPHICAL SETTING

The Cuyahoga River is about 100 miles long and drains some 810 square miles of northeastern Ohio as shown on Figure 1. The river begins at an elevation of about 1,300 feet, several miles northeast of Burton in Geauga County, and flows in a southerly direction towards Hiram Rapids, where the direction changes southwesterly through Mantua, Kent, and Cuyahoga Falls, to the confluence with the Little Cuyahoga River at Akron. From Akron, the river flows north to Cleveland, to an elevation of about 570 feet. The lower 5.8 miles are part of an existing Federal navigation project for Cleveland Harbor, one of Lake Erie's major ports.

The main tributaries of the Cuyahoga River are: Big, Mill, Tinkers, Yellow, and Chippawa Creeks; Mud Brook, Furnace Run, Little Cuyahoga River, Congress Lake outlet (Breakneck Creek), and West Branch Cuyahoga River. The overall basin consists of rolling hills and many natural small lakes and ponds. A relatively distinct escarpment near Cleveland divides the basin between an upland plateau and the narrow lake plain.

2. STUDY AUTHORITY

The Cuyahoga River Restoration Study was initiated by the Flood Control Act of 1968 (Section 219) which authorized a survey of the "Cuyahoga River from Upper Kent to Portage Trail in Cuyahoga Falls, OH, in the interest of flood control, pollution abatement, low-flow regulation, and other allied water purposes." No studies were completed under the 1968 authorization because of adverse public reaction to the limited study scope as presented at the initial public meeting on 16 September 1970. At this meeting, local interests stated their desire for environmental and aesthetic improvement programs to complement existing and proposed flood control studies. This led to the expansion of the scope of the study under the authority of Section 108 of the 1970 River and Harbor Act, that instructed the Secretary of the Army, acting through the Chief of Engineers to "investigate, study, and undertake measures in the interest of water quality, environmental quality, recreation, fish and wildlife, and flood control, for the Cuyahoga River Basin, OH. Such measures shall include, but not be limited to, clearing, snagging, and removal of debris from the river's bed and banks; dredging and structural works to improve streamflow and water quality; and bank stabilization by vegetation and other means."



CUYAHOGA RIVER, OHIO
RESTORATION STUDY

ORIENTATION MAP

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979

FIGURE 1

The authorization was sponsored by the Cuyahoga River Reclamation Commission, an agency of the city of Cuyahoga Falls. Congressional support came from former Senator Stephen M. Young, Congressman J. William Stanton (11th District) and former Congressman William H. Ayres (14th District). The 1970 authorization was sponsored by Congressman Louis B. Stokes (21st District) and former Congressman Charles A. Mosher (13th District).

The following is the text of the Authorization:

a. Flood Control Act of 1968

"Sec. 219. The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes including channel and major drainage improvements . . . to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the localities specifically named in this section. After the regular or formal reports made on any survey authorized by this section are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law except that the Secretary of the Army may cause a review of any examination or survey to be made and a report thereon submitted to Congress, if such review is required by national defense or by changed physical or economic conditions . . . Cuyahoga River from Upper Kent to Portage Trail in Cuyahoga Falls, Ohio, in the interest of flood control, pollution abatement, low flow regulation, and other allied water purposes. . ." (underline added)

b. River and Harbor Act of 1970

"Sec. 108. (a) The Secretary of the Army, acting through the Chief of Engineers, is authorized to investigate, study, and undertake measures in the interests of water quality, environmental quality, recreation, fish and wildlife, and flood control, for the Cuyahoga River Basin, Ohio. Such measures shall include, but not be limited to, clearing, snagging, and removal of debris from the river's bed and banks; dredging and structural works to improve stream flow and water quality; and bank stabilization by vegetation and other means. In carrying out such studies and investigations the Secretary of the Army, acting through the Chief of Engineers, shall cooperate with interested Federal and State agencies." (underline added)
(b) Prior to initiation of measures authorized by this section, such non-Federal public interests as the Secretary of the Army, acting through the Chief of Engineers, may require, shall agree to such conditions of cooperation as the Secretary of the Army, acting through the Chief of Engineers, determines appropriate, except that such conditions shall be similar to those required for similar project purposes in other Federal water resources projects." (underline added)

3. PURPOSE OF 3rd INTERIM REPORT AND PRELIMINARY FEASIBILITY REPORT

a. 3rd Interim Report - Erosion of the stream channels and land surfaces feeds large quantities of sediments to the Cuyahoga River where it impairs water quality, aggravates flooding problems, depresses oxygen levels, and alters aquatic life. When the river transports this sediment to the relatively quiet waters of the navigation channel at Cleveland, OH, it is deposited and forms shoals. These shoals must then be removed by maintenance dredging, costing in excess of $4,000,000 annually.

Due to the seriousness of the problem in the Cuyahoga River watershed, the Buffalo District initiated a 3rd Interim Report on Erosion and Sedimentation in Fiscal Year 1977. The purposes of this study are to determine the prolific sources of sediment throughout the basin (from land and streambank erosion) and identify methods of controlling erosion and sedimentation through structural and/or nonstructural means. The benefits that would be realized by an erosion and sediment reduction program would include, but not be limited to, the following:

(1) A reduction in sediment transported to Cleveland Harbor, thereby reducing the dredging effort needed in maintaining the harbor.

(2) Reduced sediment in the Cuyahoga River would lessen the turbidity of the water, creating a more healthful habitat for fish and would present a more aesthetically pleasing appearance to visitors in the area.

(3) Reduced shoaling in the river would reduce flood levels in floodprone areas such as in the vicinity of Valley View.

b. Preliminary Feasibility Report - The purpose of this Preliminary Feasibility Report (PFR) is to present a summary of the results of the Stage 2 planning effort conducted since initiation of the erosion and sedimentation study. This planning effort included detailed studies to identify and quantify the major sources of sediment in the Cuyahoga River watershed as discussed in paragraph 14 and formulation and assessment of a wide range of alternative measures for addressing the erosion and sedimentation problems of the area. These alternatives were developed in sufficient detail to provide initial choices as to the range of viable resource management options available in the study area. They did not concentrate on detailed engineering or design considerations. However, the alternatives were developed in sufficient detail to: (1) identify all major components of each alternative; (2) to estimate the first cost of construction and the annual operation and maintenance cost associated with each alternative; (3) to estimate the benefits associated with each alternative; and (4) to assess the impacts of each alternative on the existing environment based on the environmental data that was available.

At the conclusion of this PFR, a recommendation will be made as to whether or not to continue the study into Stage 3 planning (Development of Detailed Plans). In addition, if the recommendation is to proceed into Stage 3 planning, the most feasible alternative plans that should be investigated will be identified. These recommended alternative plans would then be developed in sufficient detail so that a rational choice could be made among them and, if appropriate, an alternative could be recommended for implementation.

4. SCOPE OF THE EROSION AND SEDIMENTATION PRELIMINARY FEASIBILITY STUDY

Although the Cuyahoga River drains an area of approximately 810 square miles, the scope of this Preliminary Feasibility Study was directed towards identifying the sources of erosion and determining the feasibility of providing erosion control measures in the 303 square-miles of the Cuyahoga River Basin between Independence, OH (river mile 13.8) and Old Portage, OH (river mile 40.25) (see Figure 2). This reach of the river was identified by Dr. Robert Apmann in his report an "Erosion and Sedimentation in the Cuyahoga River Basin" (1973) as the most prolific source of sediment in the river system. A copy of Dr. Apmann's report is included in Appendix E as Exhibit E-1. Additional studies undertaken for this report include the following:

a. A one-year suspended sediment gaging program by the U. S. Geological Survey (USGS) on the Cuyahoga River and its six major tributaries within the study area to verify Dr. Apmann's findings and to obtain an estimate of the annual suspended sediment yield from this reach of the Cuyahoga River (Exhibit E-2 in Appendix E).

b. A bank erosion study on the Cuyahoga River and its principal tributaries conducted by the U.S. Soil Conservation Service (SCS) to determine annual rates of bank erosion.

c. A land use inventory conducted by the SCS to identify and quantify areas in the basin where sheet erosion is occurring or could occur.

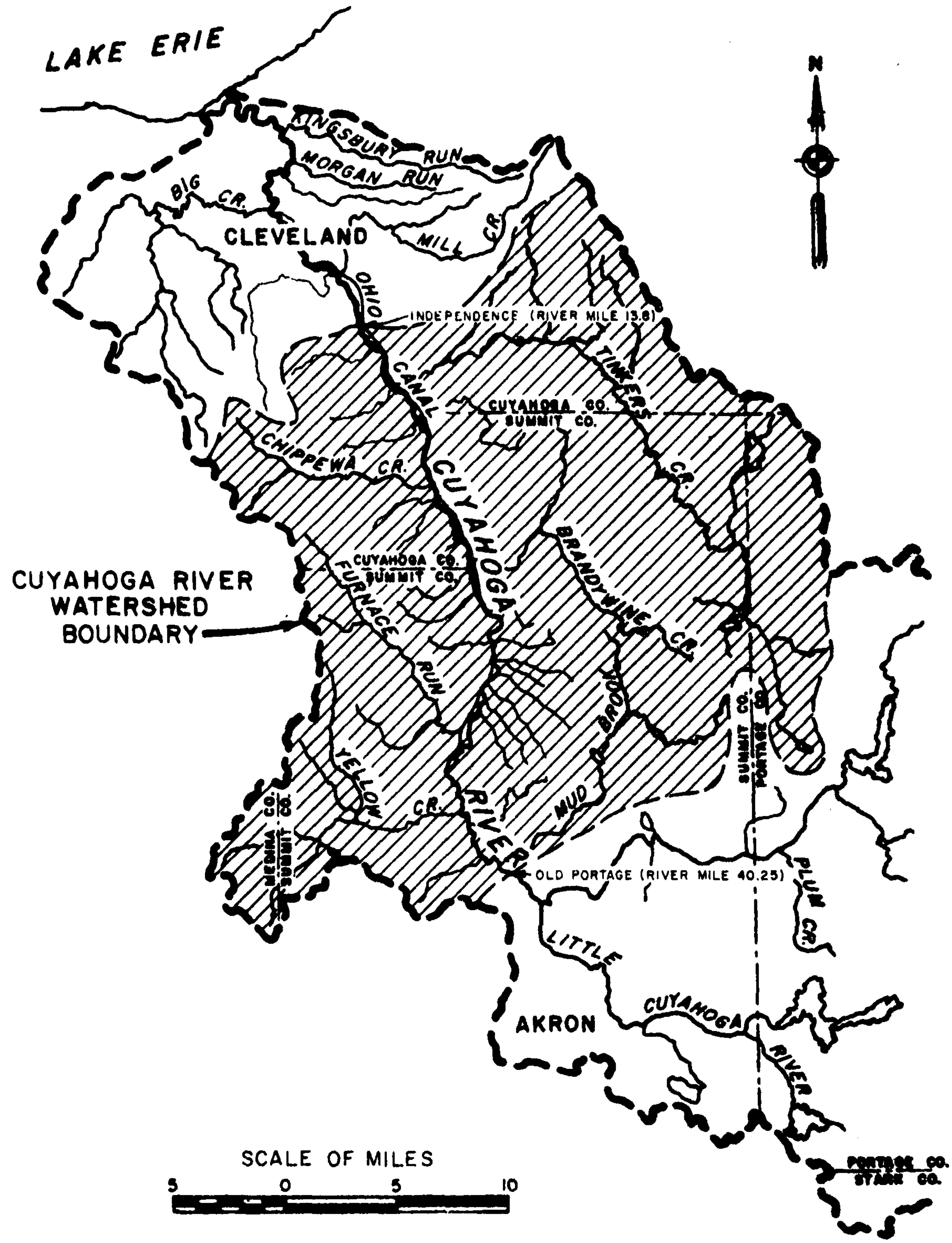
d. An inventory of the existing vegetation types along the banks of the Cuyahoga River and the first 6.5 miles of Tinkers Creek by the SCS. The results of this inventory are shown on Plates 1, 2, and 3 in Appendix I.

e. A "Planning Aid Letter," prepared by the U.S. Fish and Wildlife Service, which provides a general overview of the fish and wildlife resources of the study area and a preliminary assessment of the study to date (Exhibit E-3 in Appendix E).

f. A series of computer-generated resource maps which identify potential critically-eroding land areas in the study area. These maps were developed by the Ohio Department of Natural Resources (ODNR) utilizing their Ohio Capability Analysis Program (OCAP).

5. STUDY PARTICIPANTS AND COORDINATION

a. General - The decision to concentrate the study effort on the erosion and sedimentation problem at this time was predicated on input provided by study participants at an 18 August 1976 meeting in Columbus, OH, and a 19 August 1976 meeting in Cleveland, OH. In addition, public views on this course of action were solicited by a public notice issued by the Buffalo District Engineer on 3 January 1977. Minutes of the meetings and the responses to the public notice are presented in Appendices B and C of the "Revised Plan of Study, Cuyahoga River Restoration Study" (January 1978).



LEGEND:

STUDY AREA FOR EROSION AND SEDIMENTATION STUDY

CUYAHOGA RIVER, OHIO
RESTORATION STUDY

STUDY AREA ORIENTATION MAP

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979

FIGURE 2

b. Principal Study Participants - This Preliminary Feasibility Report is the result of a joint study effort between various Federal agencies through Interagency Agreements with the Buffalo District. The U.S. Soil Conservation Service performed most of the technical tasks associated with identifying and quantifying the eroding areas and the preliminary design of alternatives for reducing erosion of the stream channels and land surfaces. The U.S. Geological Survey conducted a suspended sediment sampling program to quantify the suspended sediment yield from the study area. The U.S. Fish and Wildlife Service conducted a literature search of the existing fish and wildlife resources of the study area and assessed the impacts of the various alternatives developed by the SCS on these resources.

In order to keep the various principal study participants informed on the progress and direction of the various studies conducted for this PFR, two workshop meetings were held on 15 November 1977 and 15 March 1978. These meetings also provided an opportunity for the principal study participants to discuss any problems concerning the study and to arrive at various solutions to these problems. Minutes of these workshop meetings are provided in Appendix F as Exhibits F-1 and F-2.

In addition to the principal study participants discussed above, the Northeast Ohio Areawide Coordinating Agency (NOACA) and the Ohio Department of Natural Resources (ODNR) provided significant contributions to this study. NOACA provided land use data for Cuyahoga, Summit, Geauga, Medina, and Portage Counties and ODNR provided computer capability to prepare the resource maps showing the location of potential critically-eroding areas. These maps will be discussed in greater detail in Section C of the Main Report.

c. Public Involvement - This preliminary feasibility study was conducted in close cooperation with other Federal and State agencies, local and regional officials, and interested groups and individuals through written and verbal communication. Typical correspondence, significant in the development of this Stage 2 study, is provided in Appendix G (Pertinent Correspondence). In addition, an interagency coordination meeting was held on 16 November 1977 to update Federal, State, regional, and local agencies on the progress and future efforts of the study. Minutes of this meeting are provided in Appendix F as Exhibit F-3.

Following approval of this Preliminary Feasibility Report, the report will be distributed to the political leaders in the area and to various local, State, and Federal agencies for their review and comment. In addition, loan copies of the report will be provided to local libraries for review by the general public and various civic groups. All comments made as a result of this review will be given equal consideration in determining the future direction of this study.

d. Coordination of the Preliminary Feasibility Report - The Preliminary Feasibility Report (November 1979) for this study was coordinated with and reviewed by North Central Division and Office, Chief of Engineers. Based on this coordination and review, a limited number of revisions have been incorporated into the text presented herein. In addition, a separate study was conducted by the Buffalo District to verify the results of the Soil Conservation Service's annual streambank erosion study. This verification study consisted of: (1) Determining the historical rate of bank recession at randomly selected locations based on the position of the river banks for 2 separate years as shown on aerial photography for 1938 and 1979; and (2) comparing these historical bank recession rates with the recession rates estimated by the SCS. The results of this verification study were that the SCS estimate of streambank erosion was accurate to the degree necessary for making an assessment of the problem and no further verification studies were required for this Preliminary Feasibility Report. Additional details on this verification study are provided as Inclosure 1 to Appendix A - "Identification of Sources of Erosion."

6. THE REPORT

The overall organization of this report consists of a Main Report, a series of technical appendices (Appendices A through D), Reports of Others (Appendix E), a Public Involvement Appendix (Appendix F), a Pertinent Correspondence Appendix (Appendix G), a Study Management Appendix (Appendix H), and a Plate Appendix (Appendix I).

The Main Report is a nontechnical summary of the results of this preliminary feasibility study, understandable to the layman, and includes information on plan formulation and selection procedures; division of project responsibilities between Federal and non-Federal interests; and the conclusions and recommendations of the study. The technical appendices provide additional detailed information on the studies conducted to identify and quantify the sources of erosion and sedimentation in the study area (Appendix A), the hydrology and hydraulics of the study area (Appendix B), the design of the alternatives formulated to control erosion and sedimentation in the study area (Appendix C), and the economic evaluation of the alternatives (Appendix D). Reports of Others (Appendix E) includes copies of: (1) Dr. Apmann's report on "Erosion and Sedimentation in the Cuyahoga River Basin" (1973); (2) the USGS report on their one-year suspended sediment gaging program; and (3) the USF&WL Service "Planning Aid Letter." The Public Involvement Appendix includes minutes of the workshop meetings conducted during the course of this study. The Pertinent Correspondence Appendix includes copies of pertinent correspondence with organizations and individuals, significant in the development of this Stage 2 study. The Study Management Appendix contains a revised "Study Flow Network" which outlines the future major study activities for the 3rd Interim Report on Erosion and Sedimentation. The Plate Appendix (Appendix I) includes all the plates developed for this report for easy reference. This appendix is contained in a separate oversized volume because the plates developed for this report could not be reduced to the standard report size without losing clarity.

7. PRIOR STUDIES AND REPORTS

Many studies of the water resources problems and needs in the Cuyahoga River Watershed have been made. The following is a summary of the various reports pertinent to the erosion and sedimentation problem which is the concern of this preliminary feasibility study:

a. Beginning in 1914, there have been 13 Corps of Engineers reports that address improvements to and modification of the Cleveland Harbor commercial navigation project at Lake Erie and the mouth of the Cuyahoga River. The most recent of these reports is the "Cleveland Harbor, OH, Feasibility Report for Harbor Modification" (June 1976), which recommended modifications to the lakefront portion of the harbor in order that 1,000-foot ore carriers could safely and efficiently utilize the harbor. Authorization to conduct a Phase I General Design Memorandum (GDM) for these improvements was provided in Section 175 of the 1976 Water Resources Development Act (Public Law 94-587), and the "reformulation" Phase I GDM is underway, having been initiated by the Buffalo District in Fiscal Year 1979.

b. The "Review of Reports on Cleveland Harbor" (February 1945) investigated, among other things, the feasibility of constructing a settling basin for sediment above the head of navigation either by means of a channel extension or a permanent reservoir in the valley south of Cleveland. The report concluded that this work was not economically justified at that time.

c. A 1952 survey report by the Soil Conservation Service of the U.S. Department of Agriculture entitled: "Program for Runoff and Waterflow Retardation and Soil Erosion Prevention," recommended that improvements in these interests be implemented over a 20-year period at a total estimated first cost of approximately $900,000. Average annual benefits were estimated at about $585,000 ($435,000 for increased agricultural productivity and $150,000 for sediment reduction), resulting in a benefit-to-cost ratio of 3.7 to 1.0. Except for a tree planting program conducted from 1953 to 1955 by local interests, this program was never implemented.

d. In response to U.S. House of Representative's Committee resolutions of 28 December 1946 and 9 June 1960, the Buffalo District prepared a report entitled "Review of Reports for Flood Control and Allied Purposes, Cuyahoga River, OH" (1 September 1969) recommending:

(1) Improvements for flood control and streambank erosion in the nine-mile reach of the Cuyahoga River between the Harvard-Denison Bridge (approximate river mile 7) and the mouth of Tinkers Creek (approximate river mile 16).

(2) Construction of a sediment settling basin in the vicinity of river mile 8.0 (approximately two miles upstream from the head of commercial navigation) in the interest of commercial navigation, pollution abatement, and Lake Erie restoration.

The report was returned to the Buffalo District in June 1970 as the necessary local assurances were not furnished to cover the cost sharing requirements for a cash contribution in return for windfall benefits. For this reason, and because subsequent legislation for the Cuyahoga River Restoration Study under Section 108 of the 1970 River and Harbor Act provided for expanded study scope, no further action was taken on the 1969 Review of Reports.

e. In August 1973, the Buffalo District completed the "Wastewater Management Study for Cleveland-Akron Metropolitan and Three Rivers Watershed Area" which evaluated alternative plans for water quality improvement in the Cuyahoga, Chagrin, and Rocky River watersheds and receiving Lake Erie by treatment of municipal and industrial waste-waters and urban storm runoff. The findings of this study, which identified four alternative land and water-oriented methods for wastewater treatment, along with the findings of similar studies conducted by the Corps of Engineers in five other areas, were submitted to both houses of Congress by the Secretary of the Army (SOA) by letter dated 28 April 1978. No recommendation for program implementation was provided by the SOA.

f. Section 108d of Public Law 92-500 directed the Corps of Engineers to develop a program for the "restoration and environmental repair" of Lake Erie. The resulting Lake Erie Wastewater Management Study (LEWWM) by the Buffalo District has identified nutrient enrichment - particularly phosphorus in all of its forms - as the primary cause of heavy eutrophication in the western basin of Lake Erie and marginal eutrophication in the central and eastern basins. The study has determined that 44 percent of the phosphorus loading to Lake Erie is from nonpoint or diffuse sources such as that attached to sediment. The study will continue through 1981, and the "Final Study Report" will use results of pilot management programs on selected Lake Erie tributary watersheds to recommend specific implementation programs for these and unmonitored watersheds in the Lake Erie Basin. Thus, the LEWWM study may ultimately identify tangible and intangible water quality and related benefits to Lake Erie by reducing erosion and sedimentation in the Cuyahoga River watershed.

g. As previously outlined in paragraph 2, the authority for the Cuyahoga River Restoration Study (CRRS), under which this 3rd Interim Report on Erosion and Sedimentation is being conducted, was provided by Section 108 of the 1970 River and Harbor Act. A synopsis of accomplishments under this authority follows:

(1) The "First Interim Report" (September 1971) presented the scope of the longer-term Framework Plan plus an Early-Action Program for the Cuyahoga River Restoration Study. The Framework Plan presented a description of the basin's resource problems and needs, and possible alternative means of dealing with these problems and needs. Sources of pollution and other degradable conditions were sought out and identified. Current pollution abatement programs were inventoried to determine their effects on pollution. The Early-Action Program consisted of four action programs that were considered compatible with the overall framework plan and which could be constructed or accomplished without additional study. The four early-action programs were:

(a) Recreational improvements such as canoe docks and landscaping at Waterworks Park-Cuyahoga Falls (river mile 49.0) and Fuller Park-Kent (river mile 54.0). In a letter to Congress dated 25 September 1975, the Secretary of the Army deferred these proposed recreational facilities. The Secretary also indicated that these facilities would be reviewed in subsequent studies of the basin. As stated in the "Revised Plan of Study, Cuyahoga River Restoration Study" (January 1978), it was the consensus of the local officials that present and future recreational needs have been identified and programs for expansion to meet these needs have been outlined. Therefore, the need for improving the recreational facilities in the basin under the Cuyahoga River Restoration Study will not be investigated further.

(b) Debris removal from Cleveland Harbor. The Secretary of the Army also deferred implementation of this program because he concluded that ". . .

removal of debris outside the Federal channel should be prosecuted by non-Federal interests."

(c) Flood control and aesthetic improvements on Big Creek at the Cleveland Zoological Park. Funds to begin advanced engineering and design for this $5 million project were released in October 1975. The Phase II General Design Memorandum is presently nearing completion with construction of the project to follow.

(d) Pilot sediment removal project on the upstream side of the dam at Brecksville, OH. On 16 July 1976, the Buffalo District Engineer recommended that the Pilot Sediment Removal Project be terminated. The project showed that sediment removal was not a feasible means of improving water quality on the upstream side of the Brecksville, OH, dam because the sediment in this area was relatively unpolluted, with no oxygen depletion. This recommendation was concurred with by the Division Engineer and approved by the Office of the Chief of Engineers by letter dated 9 December 1976.

(2) One of the actions under the Cuyahoga River Restoration Study was an investigation of the existing water quality conditions in the river basin entitled "Ecological Monitoring of the Cuyahoga River" (October 1974) by Dr. John Olive of the University of Akron through a contract with the Buffalo District. The purpose of this investigation was to establish the baseline biological, chemical, and physical characteristics of the central Cuyahoga River environment; to evaluate the river's existing and unaltered projected environmental trends; and to extrapolate what the anticipated environmental changes would be as a result of implementing the Pilot Sediment Removal Program. This investigation included physiographic, chemical, physical, and biological data collection from seven sites along the Cuyahoga River, one of which was at the upstream side of the Brecksville Dam. The sampling period for this data collection program was from October 1973 to September 1974. The results of this study indicated that: (1) sediment upstream of the Brecksville dam was nonpolluted to moderately polluted when compared to EPA sediment standards; (2) sediments which are deposited on the upstream side of the Brecksville Dam in August and September are scoured during the high flow regimes of February and March; and (3) the water at the Brecksville site was always well oxygenated and the dissolved oxygen level never fell below 5 ppm. The results of this study were utilized in terminating the Pilot Sediment Removal Project (an early-action program).

(3) The "Second Interim Report" (March 1976) identified the significant flooding problems within the Cuyahoga River Basin and developed corrective plans for these problems. The flood problem areas studied in the "Second Interim Report" were: Lower Cuyahoga, village of Mantua, Hudson Village, city of Streetsboro, and Twinsburg. In the report, it was concluded that flood control correction plans could not be economically justified for the flooding problems in the Cuyahoga River Basin (excluding the Big Creek improvements). Further, it was recommended that, in general, the affected communities implement flood plain management programs to prevent increased flood damages. The Corps can assist the communities in developing their programs under the Technical Assistance portion of the Flood Plain Management Program.

h. In November 1977, the Buffalo District completed a Section 14 report entitled "Erosion of Cuyahoga Riverbank Along Stone Road in Valley View, OH." The purposes of this report were to develop a plan for the protection of about 300 feet of Stone Road in Valley View, OH, against further damage and possible total destruction from the continuing erosion of the adjacent bank of the Cuyahoga River and to evaluate the economic feasibility of the protection project. The investigation indicated that the erosion problem on the Cuyahoga River along Stone Road was critical and the loss of Stone Road would have a significant adverse impact on the physical and social well-being of the local residents. The investigation also indicated that the most economical solution to the problem was to relocate approximately 600 feet of Stone Road away from the river. Since relocation costs are the responsibility of local interests no further Federal action was warranted.

SECTION B
PROBLEM IDENTIFICATION

The purpose of this section is to inform the reader of this report of the water and related resource problems and needs, or lack thereof, in the study area and for which this study seeks a solution. The section presents information on the existing physical, biological, and human environment in the general area; discusses the need for identifying and quantifying the sources of sediment throughout the study area (from land and streambank erosion) and identifying methods of controlling erosion and sedimentation; reviews the planning constraints under which this study was conducted; discusses the specific planning objectives of the study; and reviews the conditions that would exist if no Federal action was taken.

8. EXISTING CONDITIONS

a. Physical Environment

(1) River Basin Description - The Cuyahoga River (see Figure 1) is about 100 miles long and drains some 810 square miles of northeastern Ohio. The river begins several miles northeast of Burton in Geauga County and flows in a southerly direction towards Hiram Rapids, where the direction changes southwesterly through Mantua, Kent, and Cuyahoga Falls, to the confluence with the Little Cuyahoga River at Akron. From Akron, the river flows north to Cleveland. The lower 5.8 miles of the river is part of the harbor facilities for the Port of Cleveland, one of Lake Erie's major ports.

(2) Topography - The land forms of the Cuyahoga River Basin lie within the glaciated Appalachian Plateau Province. The gently to moderately sloped and rolling uplands are formed of ground and end moraines. The soil materials of clay, silt, sand, and gravel till are laid down over bedrock shales and sandstones, generally modeled by the Wisconsin stage of the glacial period and subsequent drainage development.

Prior to the glacial advance, drainage in the lower valley area was to the north, as it is now. Indications of ancient flow from the southeastern part of the area show as buried valleys that drained south and southwestward. Moraine deposits forming a ridge just south of the area have resulted in diking against southward flow from the upper Cuyahoga Basin. Hence, since the latter stages of melt and development of the post glacial drainage patterns at the end of the glacial period, drainage has cut across old water divides connecting the recent upper and lower systems into one, the present Cuyahoga River.

To some extent the flow of the Cuyahoga River has recaptured the pre-glacial northward flowing river valley. The present lower valley is primarily a depositing one and further extensive downcutting is essentially prevented by the present level of Lake Erie. The floor of the lower valley slopes at an average rate of 8.3 feet per mile from Peninsula, to the Southerly Wastewater Treatment Center, at Garfield Heights.

Valley walls in the lower valley rise from the flood plain at about 580 feet elevation to near 800 feet, at slopes of 10 percent to 70 percent. The adjacent basin uplands slope at less than 10 percent to elevations of 1,100-1,200 feet. These higher elevations occur as ridges generally defining the basin perimeter to the west and east of the lower valley.

The uplands enclosed in the broad U-shaped course of the Cuyahoga River are in part a gently sloping basin draining northwestward through tributaries, Tinkers and Brandywine Creeks. Several proportionately large areas of this plateau basin are poorly drained, swampy or marshy and frequently underlaid by waterbearing deposits.

Other portions of the upper elevations of this eastern part of the basin are rolling topography of hillocks, and kames of sands and gravels.

The sharpest relief is found generally along the tributary streams cut into the edge of the lower valley. The Appalachian Plateau edge, known as the Portage Escarpment, generally extends along both sides of the valley at about the 750 to 850-foot elevations. Upper strata forming this feature is the erosion resistant Berea Sandstone.

Incised gorges cut by the tributaries are characterized by very steep walls and cliffs of shales, capped by the sandstone wherever these streams are cutting into bedrock. Falls, and steep gradient reaches over rough broken rock blocks and boulders, are common to the upper gorge sections.

Some tributary streams are cutting into till deposits in pre-glacial tributary valleys. The slopes along these streams are less steep and characterized by slippage and collapse (or land slides) caused by unstable materials in the till and associated groundwater. (Cleveland Regional Sewer District (C.R.S.D.) 1976:6-8).

(3) Climate - The climate of the Cuyahoga River Basin is mainly humid, continental in character, with an annual average precipitation of 30.6 to 44.2 inches. The basin experiences strong, modifying influences from Lake Erie. Northwesterly winds crossing Lake Erie tend to lower temperatures in the summer and raise them in the winter with an annual average of 49.1 degrees Fahrenheit. Winds blowing across the lake in winter often bring heavy snow squalls, sometimes as late as May. The snowfall range varies from 46.7 to 109.3 inches per year.

Prevailing winds are from the southwest throughout the year with the average velocity being approximately 10 miles per hour. Damaging winds of 35 to 85 miles per hour occasionally occur in spring and summer associated with thunderstorms.

The river basin gives rise to various microclimatic conditions due to the changing topography. These features allow for freezes at abnormal periods which allows vegetation of more northern latitudes to take hold and grow. (C.R.S.D., 1976).

(4) Geology - Rock strata of the Devonian, Mississippian, and Pennsylvania sedimentary systems are exposed throughout the Cuyahoga River Basin. These deposits are economically important and support a shale and sandstone industry.

Older systems of Silurian, Ordovician, and Cambrian are frequently encountered during periods of drilling for wells or other shafts.

Surface exposures of Devonian Chagrin and Ohio shales, Mississippian Bedford formation, Berea Sandstone, and Cuyahoga Group shales and sandstones are best exposed in the lower valley and the gorges of tributaries joining it. The Berea sandstone is the more resistant of these rocks to the forces of erosion that have shaped the valley. In general, this rock forms the abrupt edge of the Portage Escarpment to the east of the valley. It is also present to the west but the relief is less abrupt.

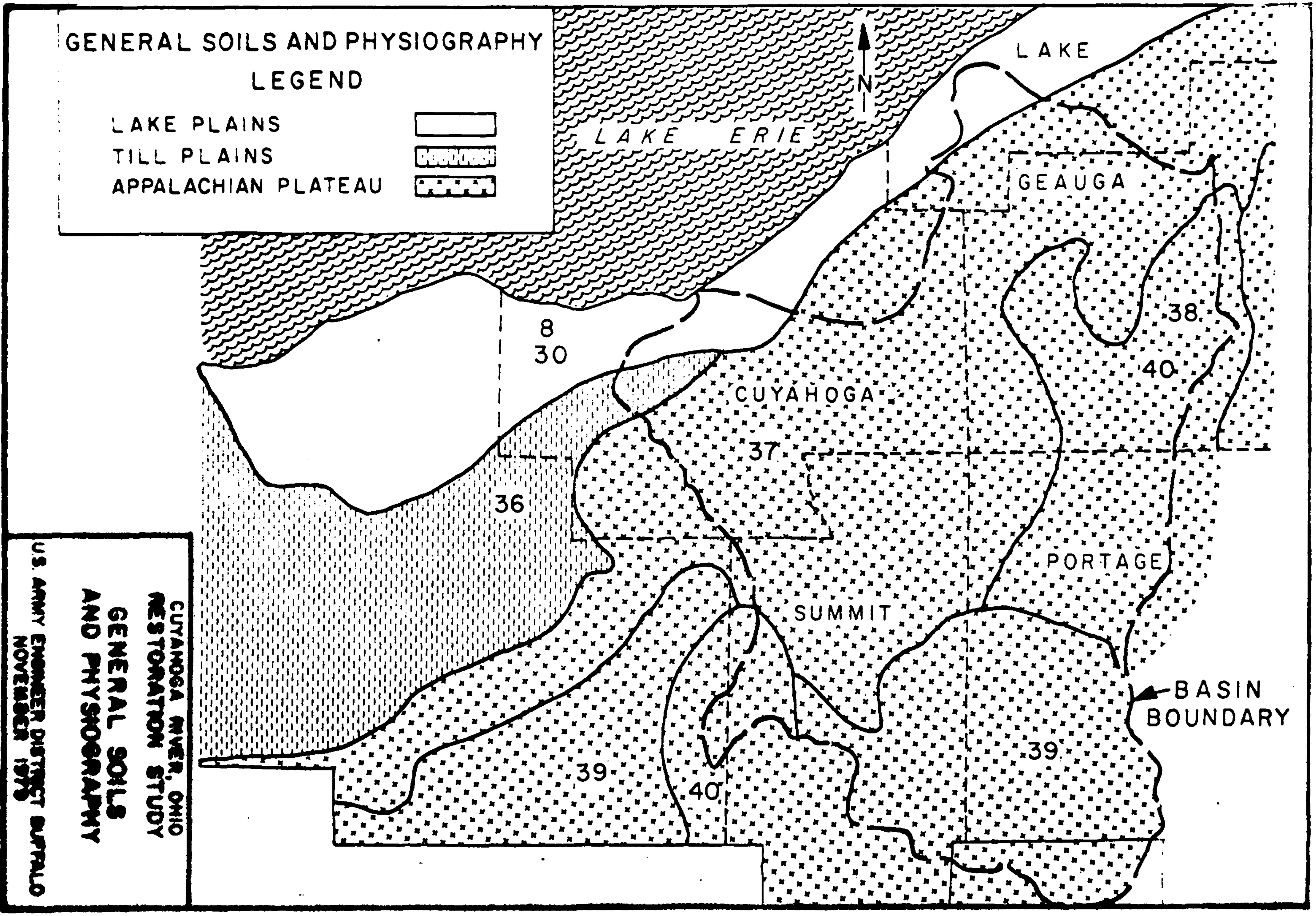
Pennsylvania age rocks of the Pottsville Formation are found to the south and east in the study area lying unconformably on the Mississippian. The complete series of Pottsville is a sequence of coals, shales, limestones, and sandstones. Sharon Conglomerate, a sandstone, is the lower and more widespread Pennsylvanian layer in the service area. (C.R.S.D., 1976:18).

(5) Soils - The general soil and physiography map shown in Figure 3 outlines the major soil associations and physiographic areas of the Cuyahoga River Basin. Table 1 lists these major soil associations and compares their fertility and drainage characteristics.

The lake plain is characterized by level or nearly level expanses broken by sand beach ridges. The area is underlain by shale and sandstone bedrock and occupies the northern parts of Lorain, Cuyahoga, and Lake Counties. The till plain is characterized by large, nearly level to gently rolling areas underlain by silty clay loam to clay loam glacial till and by sandstone or shale bedrock. The lake and till plains are for the most part poorly drained. The Appalachian Plateau is characterized by nearly level to sloping lands. The steep slopes occupy the sides of major stream valleys and have a high erosion potential. In general, the Appalachian Plateau soils are not as saturated as the soils of the lake and till plain areas. (NOACA, 1978).

(6) Air Quality - The Cuyahoga River Basin is located within the Greater Metropolitan Cleveland Intrastate Air Quality Control Region which includes the counties of Lorain, Cuyahoga, Lake, Geauga, Summit, Medina, Portage, and Stark. This Air Quality Control Region is classified according to the severity of the existing pollutant concentration as follows: particulate matter - Priority I, sulfur oxides - Priority I, nitrogen dioxide - Priority III, carbon monoxide - Priority III, and photochemical oxidants - Priority I. (CRSD 1976:10).

The national primary ambient air quality standards for particulate matter are: (1) 75 micrograms per cubic meter - annual geometric mean, and (2) maximum 24-hour concentration not to exceed 260 micrograms per cubic meter more than once per year. The national secondary ambient air quality standards for particulate matter are: (1) 60 micrograms per cubic meter - annual



CUYAHOGA RIVER, OHIO
RESTORATION STUDY

GENERAL SOILS
AND PHYSIOGRAPHY

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979

FIGURE 3

Table 1 - Drainage Limitations of Soils in Cuyahoga River Basin (Adapted from GLBC, 1975)

Soil Association	Soil Series	Permeability of Most Restricted Layer	Natural Fertility	Percent of Association Needing Drainage
8	Mixed sands	Rapid	Low	30
30	Painesville Caneadea Canadice	Slow	Medium	60
36	Mahoning Trumbull	Slow	Medium	90
37	Ellsworth Mahoning	Slow	Medium	40
38	Wayne Rittman Wadsworth	Slow	Medium	30
40	Wooster Canfield Ravenna	Slow	Medium	30

geometric mean, and (2) maximum 24-hour concentration not to exceed 150 micrograms per cubic meter more than once per year. In the case of Ohio, the State adopted the more stringent national secondary standards, and must meet these regulations by 15 April 1977 to comply with the Clean Air Amendment Act of 1970.

The region's economy is largely based upon heavy industrial operations including production of iron and steel, chemicals, rubber products, and minerals. These industries are by far the main source of particulate and sulfur oxide emissions, which also constitute a high proportion of the total of the air pollutants in the U.S. generally.

Geographic configuration contributes significantly to the alarming levels of pollution. The land features most important in distributing air are the Cuyahoga River Valley and the ridge on the southeastern edge of Cleveland, which is also the site of several major industries. Winds from Lake Erie play an important part in air distribution, modifying the vertical stability structure over the region and bringing in relatively clean air, which forces the pollution toward inland locations up to the river valley (Doxiadis Associates International 1973).

Air quality is variable depending on turbulence, wind direction, and thermal stratification of the atmosphere. The surrounding horizons are usually shrouded in smog. The nearest air-quality monitoring stations to central Cuyahoga Valley are at Valley View, Peninsula, and Twinsburg. In general, the levels of most monitored pollutants are lower than in downtown Cleveland or Akron, but substantially higher than in other rural parts of Ohio.

Activities in the national recreation area itself, other than vehicular traffic (a major contributor), generate almost no onsite air pollution (NSP 1976:37).

(7) Erosion and Sedimentation - A variety of sources feed large quantities of sediment into the Cuyahoga River. When the river transports this sediment to the relatively quiet waters of the navigation channel at Cleveland, Ohio, it is deposited and forms shoals. These shoals must then be removed by maintenance dredging costing in excess of $4,000,000 annually.

The sediment that reaches Cleveland Harbor is heavily polluted with large amounts of iron, nitrogen, phosphates, oil, grease, and other toxic substances. The latest sediment sampling program was conducted by the U.S. Environmental Protection Agency (EPA) from August to November 1977. The results of the sampling program indicated that the sediment is heavily polluted based on USEPA standards, although improvement in the sediment quality was noted from their previous sampling program conducted in 1972.

Because the sediment that is dredged from Cleveland Harbor is heavily polluted, it is placed in diked disposal areas in lieu of traditional open-lake dumping. During the period of 1970-1974, virtually all of the dredged material was placed in two diked disposal areas constructed in the late 1960's as part of a pilot study of dredging and water quality problems in the Great Lakes. From 1972 to the fall of 1974, harbor dredging was reduced to selective dredging in the Cuyahoga River because of the lack of adequate storage volume in the diked disposal areas. As a result of the reduced dredging, the Cuyahoga River channel was maintained at less than its authorized depth.

The pilot dredging and water quality study of the late 1960's led to enactment of legislation in 1970 (Public Law 91-611) which authorized the construction of spoil disposal facilities of sufficient capacity for a period not to exceed 10 years. A new dike disposal area (Site 12) was constructed next to the earlier pilot dikes and was operational in the fall of 1974. This new dike disposal area, which has a capacity for about three and one-half years of dredging, is the first stage of the 10 year dike disposal program. A second diked area, opposite Gordon Park (Dike 14) to contain the remaining six and one-half years of dredging, is currently under construction and is scheduled to be complete in 1979.

(8) Water Quality - During the summer of 1967, an extensive study of the water quality conditions in the Lower Cuyahoga River and its major tributaries was conducted (COE, Buffalo, 1971:A-1). The discussion from that study considers the data collectively for different reaches of the river and for the major tributaries which are listed below (see Figure 4):

Reach 1 - Lake Rockwell to Kent Wastewater Treatment Plant.

Reach 2 - Kent Wastewater Treatment Plant to Munroe Falls Dam.

Reach 3 - Munroe Falls to end of Gorge below Ohio Edison Dam.

Reach 4 - End of Cuyahoga Gorge to Little Cuyahoga River.

Reach 5 - Little Cuyahoga River to Akron Wastewater Treatment Plant.

Reach 6 - Akron Wastewater Treatment Plant to Furnace Run.

Reach 7 - Furnace Run to Diversion Dam at Station Road.

Reach 8 - Diversion Dam to Cleveland Southerly Wastewater Treatment Plant.

Reach 9 - Southerly Wastewater Treatment Plant to Lake Erie.

Breakneck Creek, Little Cuyahoga River, and Tinkers Creek are discussed along with the reach into which they flow.

In considering the biological conditions in the river, the various reaches are categorized as: septic zone, zone of recent pollution, zone of recovery, and clean water zone. Descriptions of the general features and characteristics of each zone are as follows:

(a) Septic zone. Water in this zone would have low dissolved oxygen (DO), high organic content, high Biochemical Oxygen Demand (BOD), dark color,

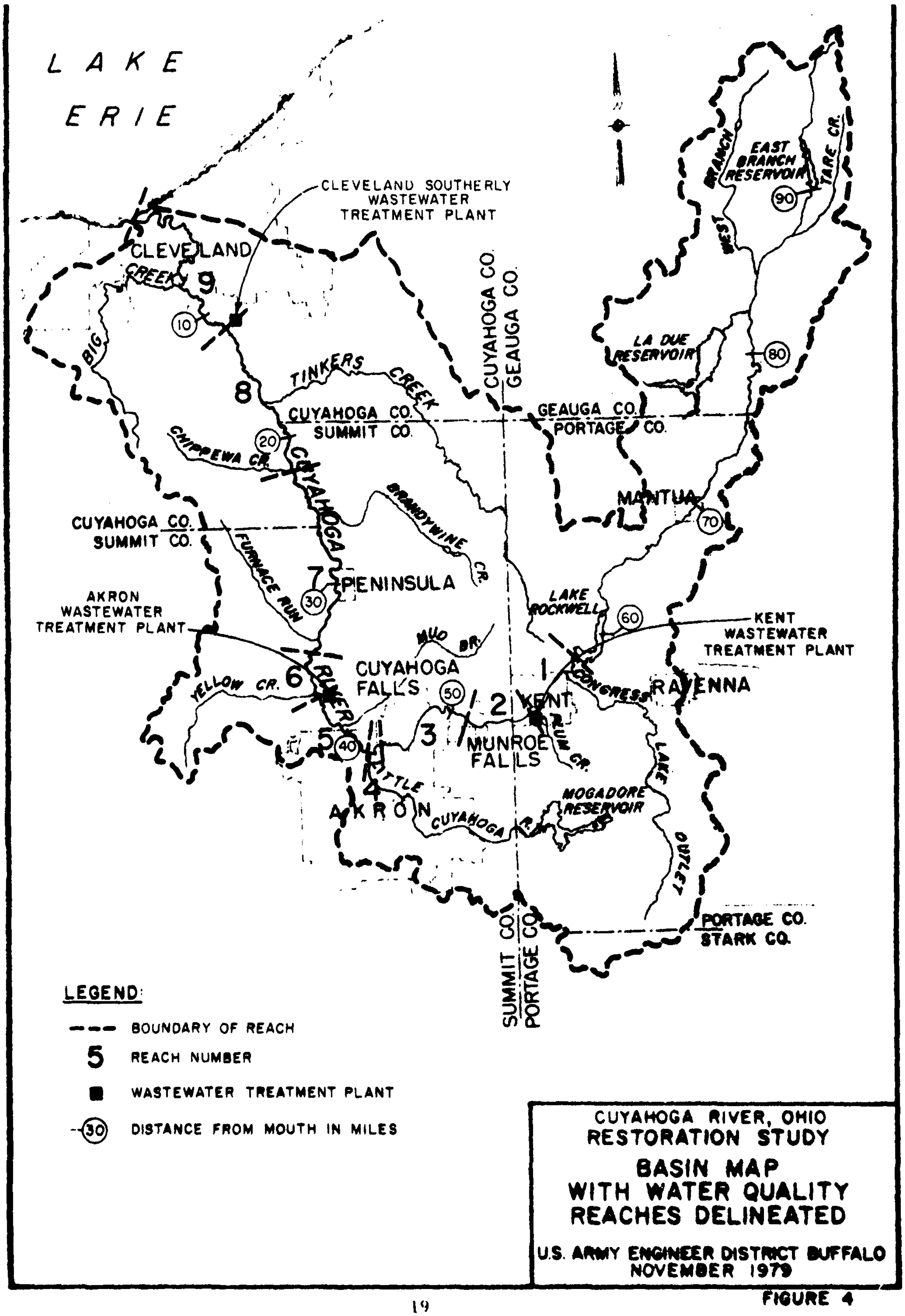

LAKE ERIE
CLEVELAND SOUTHERLY WASTEWATER TREATMENT PLANT
CLEVELAND
BIG CREEK
9
10
8
TINKERS CREEK
CUYAHOGA CO.
GEAUGA CO.
CUYAHOGA CO.
SUMMIT CO.
GEAUGA CO.
PORTAGE CO.
20
CHIPPEWA CR.
CUYAHOGA
BRANDYWINE CR.
CUYAHOGA CO.
SUMMIT CO.
FURNACE RUN
7
PENINSULA
30
AKRON WASTEWATER TREATMENT PLANT
MUD BR.
CUYAHOGA FALLS
YELLOW CR.
6
RIVER
50
2
KENT
1
3
MUNROE FALLS
5
40
4
LITTLE CUYAHOGA R.
AKRON
EAST BRANCH RESERVOIR
WEST BRANCH
TARE CR.
90
LA DUE RESERVOIR
80
MANTUA
70
LAKE ROCKWELL
60
KENT WASTEWATER TREATMENT PLANT
CONGRESS
RAVENNA
RUN CR.
LAKE
MOGADORE RESERVOIR
OUTLET
PORTAGE CO.
STARK CO.
SUMMIT CO.
PORTAGE CO.
LEGEND:
BOUNDARY OF REACH
5 REACH NUMBER
WASTEWATER TREATMENT PLANT
30 DISTANCE FROM MOUTH IN MILES
CUYAHOGA RIVER, OHIO
RESTORATION STUDY
BASIN MAP
WITH WATER QUALITY
REACHES DELINEATED
U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979

FIGURE 4

and few species of biological organisms. Typical organisms would be snails and sludgeworms.

(b) Zone of recent pollution. This zone would have low DO, but may become intermittently saturated if algae is present, high BOD, clear to grey color, and few biological species, consisting mostly of snails, sludgeworms, midge larvae, and occasionally coarse fish.

(c) Zone of recovery. This zone has increasing DO, some turbidity and color, and would usually be very productive biologically; a large number of species may be present.

(d) Clean water zone. This zone would have high DO, low BOD, low turbidity, and no color. The number of biological species may be high, but numbers of each type of species are moderate.

The following is a discussion of water quality by reaches:

Reach 1 - Lake Rockwell is an artificial impoundment supplying water to Akron and those communities served through Akron water supply. The flow of the river immediately downstream from the dam is low throughout most of the summer. Above the confluence of Breakneck Creek, the water is generally of good quality, being high in DO and low in dissolved and suspended solids. There exists a sedimentary problem in this area attributable to filter backwash from the Akron Water Plant settling ponds and organic matter carried from swamp drainage south of Twin Lakes. The low gradient sections in this area accentuate the problem.

The portion from Lake Rockwell to Breakneck Creek meets the requirements for "Aquatic Life A" classification set forth by the Ohio Stream Pollution Control Board (COE, Buffalo, 1971, Appendix "A" Water Quality). This section has a good diversity of game fish and aquatic plant species. Downstream from the confluence of Breakneck Creek, water quality decreases and pollution tolerant species of plants and fish become obvious. Degradation of environmental conditions here can be attributed to the supply of pollutants from the Breakneck tributary.

Breakneck Creek (Tributary to Reach 1) - Breakneck Creek receives effluent discharges from two sewer district treatment plants and the city of Ravenna Sewage Treatment Plant, in addition to the drainage from a large swampy area. The water prior to discharge into the Cuyahoga River is low in DO and relatively rich in nutrients.

Breakneck Creek is classified as suitable for Aquatic Life "B," being moderate in DO and high in nutrients. The low gradient of the stream allows thick deposits of organics and silt to settle along stream edges. The animals found here are pollution tolerant, however, there is diversity and relatively large populations indicating conditions for favorable aquatic life. Plant and algae species are abundant attributable to abnormal nutrient loads. Additional upgrading of treatment plants along this tributary is necessary to upgrade its biological condition.

Reach 2 - The reach from Kent to Munroe Falls Dam is a flowing pool rich in effluent nutrients. Algae blooms are frequent in summer resulting in high

BOD and high COD conditions just above the dam. Near the dam, some stratification occurs. Waters below four feet become almost entirely depleted of DO.

The upper layers of the pool support rough fish species (i.e., goldfish, carp, bullheads, etc.) The presence of algae, non-pollution tolerant forms of invertebrates (caddis fly) and higher forms of aquatic life indicate a biological zone of recovery.

Water quality conditions upstream from Munroe Falls Dam, as shown by the survey results, reflect decreases in BOD, COD, and dissolved oxygen (DO); slight decreases in total coliforms, suspended, dissolved, and total solids as well as nitrate, chlorides, and temperature.

Reach 3 - With the exception of the pool behind the dam, fish are present throughout this section of the river, although DO falls below the Aquatic Life "A" minimum in the lower layers of the pools. The absence of fish in the pool behind the dam is probably due to low DO. Downstream from the dam biological recovery is rapid and the population of animals is increased. This section of the river (except for the pool) meets Aquatic Life "A" classification.

Reach 4 - From the end of Cuyahoga gorge to Little Cuyahoga River, DO remains high and there is significant reduction in the number of coliform bacteria. The general aspects of this section of the river is pleasing and desirable species of fish appear (i.e., bluegills).

Little Cuyahoga River (tributary to Reach 4) - The Little Cuyahoga River flows through Akron and carries high concentrations of dissolved and suspended solids. Streamside dumping has added to the overall degradation of water quality and aesthetics in this reach. Oil and silt loads derived from mismanaged landfills, also enter the river here. Bioassays on the Little Cuyahoga River water have shown definite evidence of intermittent strong discharges (COE, Buffalo, 1971). The water entering the Cuyahoga here is of poor quality because of industrial and municipal wastewater. Points of toxic discharge need to be identified and remedied in order for this tributary to make any substantial biological recovery. The upper reaches of the Little Cuyahoga are of good quality and meet Aquatic Life "A" requirements.

Reach 5 - The Little Cuyahoga marks the beginning of the major deterioration of the Cuyahoga River. The load of industrial waste, municipal sewage and silt carried by the Little Cuyahoga and emptied into the Cuyahoga adversely affect the water quality in this reach.

This section, as measured by biological parameters, meets Aquatic Life "B" requirements; that is, conducive to maintenance of desired biological growths and permitting the passage of fish. Chemical and physical standards for Aquatic Life "A" are met part of the time.

Reach 6 - The reach from the Akron Wastewater Treatment Plan to Furnace Run is grossly polluted and the water quality is reduced to that of a septic zone. The effluent from Akron Wastewater Treatment Plant drastically changes the physical, chemical, and biological properties of the river water.

Heavy loads of dissolved and suspended settleable solids are evident, as well as increases in BOD, COD, bacteria, and nutrient content.

The slope of the river, from the Akron plant to Furnace Run, is slight allowing accumulation of sludge beds that are periodically washed out during high flow periods.

Most of the BOD removal in this reach is by settling and anaerobic decomposition. Low DO and the composite of chemical factors produces an extremely limited environment.

A biological survey of this reach produced only one species of algae and minimal populations of sludgeworms. No midge larvae or snails were found during sampling, exemplifying the extent of biological degradation. However, the DO was within the range to support midge fly larvae and sludgeworms, and there is enough food available to support large populations. Bioassay results (COE, Buffalo, 1971) and the absence of aquatic life indicate intermittent toxic conditions of a frequency which does not allow reestablishment of a healthy biological condition.

Tributary streams in this reach are of good quality and those with sufficient flow and depth support a variety of fish and invertebrate species.

The reach of the Cuyahoga River between the Akron Wastewater Treatment Plant and Furnace Run (excepting the navigation channel) supports the lowest populations of aquatic life of the entire system, and does not meet the requirements of water quality criteria for any use.

Reach 7 - Downstream from Furnace Run, to the head of the pool behind the diversion dam for the Ohio and Erie Canal, at Station Road, the river shows distinct signs of recovery. There are significant reductions in BOD, COD, and bacteria and DO levels are increased due to the steep slope and coarse substrate and the presence of a small waterfall.

The pool acts as a small settling basin and accumulates organic and inorganic materials as well as sludge deposits that are washed away from upstream. In addition, the pool receives BOD and suspended solid loads from a nearby paper plant and local septic tank discharges. Consequently, the deeper water near the dam becomes totally devoid of dissolved oxygen, and anaerobic conditions prevail.

Biologically, the section of the river above the pool is in a zone of recovery. Algae and some less tolerant forms of invertebrates reappear. The heavy load of organic material and the presence of periodical toxic discharges prohibit this reach from establishing a stable and diverse biological community. This is supported by the absence of rough fish and other higher forms of aquatic life which one would expect to find in a zone of recovery. Tributaries of this reach are categorized as clean water zone and zone of recovery. All support fish where the flow is sufficient.

Reach 8 - In the upper portion of this reach the flow is significantly reduced (60 to 65 cfs) by diversion through the Ohio Canal for use by industry. The drop over the Ohio and Erie Canal diversion dam replenishes the DO content significantly but downstream, due to pollution loads added by Tinkers Creek and the Brecksville Sewage Treatment Plant, the DO level decreases.

In the lower portion of this reach (below Rockside Road), the character of the river has been altered significantly by urban development. Silt loads, attributable to flood plain construction and bank erosion, have covered the gravel substrate and created mud-lined banks. In addition, water turbidity is greatly increased and these suspended soil particles create enormous sediment problems downstream in the navigation channel, where they tend to settle.

Biologically, this reach can be classified as a zone of recovery. Pollution tolerant species of invertebrates are common, and Oscillatoria is the only algae found here. No fish were collected in this reach, undoubtedly related to the pollution barriers at both ends and the heavy silt loads which tend to stifle the recovery of a balanced aquatic community.

Tinkers Creek (Tributary to Reach 8) - Tinkers Creek serves a large drainage area and receives the effluent from septic tanks and several small wastewater treatment plants along its course. The biological community, for the most part, is comprised of pollution-tolerant species.

Generally speaking the upstream reaches are of better water quality; the lower reaches increasing in color, turbidity, and suspended solids (sewage) and probably devoid of fish. However, the downstream region does have fairly good DO content due mostly to the slope characteristics which provides for reaeration.

The very large growth potential of this area poses a serious threat to further degradation of this creek and inevitably the Cuyahoga River itself. Close surveillance and careful land use planning will be needed to maintain the present water quality of Tinkers Creek and reduce the pollution load it feeds into the Cuyahoga River.

Reach 9 - The downstream reach of the Cuyahoga from the Cleveland Southerly Treatment Plant to Lake Erie is grossly polluted. The discharge of supernatant liquid with a high BOD and large quantities of suspended solids, total solids and ammonia has had a severe impact on the river. There are current improvement programs underway at several waste treatment plants to eliminate the supernatant discharge into the Cuyahoga. Additional discharges in this region include various treatment plant effluents, combined sewer overflows and polluted tributary streams, such as the Kingsbury Run.

Organic and inorganic materials precipitate and settle to the bottom. Some of these materials undergo a slow anaerobic decomposition, releasing foul gases in the process. A portion of these organic materials find their way into Lake Erie during periods of heavy runoff.

Biological life in this reach is nearly non-existent, except for an occasional sludgeworm or midge larvae found in riffles upstream. The environment is also unsuitable for nitrifying bacteria accounting for the large quantities of ammonia present, which eventually exerts its oxygen demand on Lake Erie.

In summary, the water quality of this reach does not meet criteria for any use, the principal problems being low DO, intermittent toxicity, high temperature and excessive amounts of solids, ammonia, BOD, COD, oil, floating debris, odor and turbidity.

b. Biological Environment

(1) Aquatic Biota - According to the 1974 "Ecological Monitoring of the Cuyahoga River," prepared by the Biology Department of Akron University for the COE, Buffalo District, benthic invertebrate communities sampled in the Cuyahoga River mainstream below Akron (including stations at Boston Mills, Brecksville above and below the canal diversion dam, and Independence), consist almost exclusively of pollution-tolerant oligochaetes (sludge worms), air breathing snails (Physa sp.) and chironomids. Clean-water organisms account for less than five percent of the benthic fauna. The number of insect species, as high as 79 above Akron at Hiram Rapids, declines to less than 30 at each station below Akron.

The survey also indicated that the major components of the Cuyahoga River periphyton were diatoms (Bacillariophyceae). The variety of diatoms were greatest in the upper river and lowest at stations below Akron. Approximately 140 species were received at Hiram Rapids, but less than half this in some areas below Akron (ranging from about 65 at Boston Mills to about 97 percent at Brecksville above the dam).

In recent years the incidence of algae in the Cuyahoga River mainstream is apparently decreasing. In 1968 a biological survey of the Cuyahoga watershed was conducted. Algae was collected at every one of 11 sampling stations between Bath Road and Rockside Road (Independence). The blue-green alga Oscillatoria sp. was collected at every one of these sites and at eight of 11 sites was the only alga found. Two green algae (Stigeoclonium sp. and Cladophora sp.) grew on rocks in riffle area in the vicinity of Ohio Route 303, Boston Mills Road, and Rockside Road. Spirogyra sp. and Euglena sp. also were collected at the latter station, which was considered to be in a zone of recovery from heavy organic pollution.

In a later (1971) investigation conducted by the Army Corps of Engineers a few algae were observed. One genus, probably Oscillatoria sp., was reported from the river segment between the Akron wastewater treatment plant and the mouth of Furnace Run. A few additional species were observed in the recovery zone from the effluent of the Akron (Botzum) treatment plant between Furnace Run and a diversion dam at Station Road. Oscillatoria sp. was the only alga collected downstream from the diversion dam to the Cleveland Southerly wastewater treatment plant.

Although plant nutrients are abundant in the river, toxic wastes, high turbidities, and poor substrates inhibit the growth of aquatic plants throughout the middle and lower segments of the river.

Sixty-eight species of fish were known to occur in the Cuyahoga River mainstream before 1950. Presently few fish can survive the chronic organic pollution and frequent toxic conditions which characterize the river below Akron. According to the U.S. Department of Interior Bureau of Outdoor Recreation, the river no longer constitutes a viable fishing resource. Investigations in 1971 and 1972 by Dr. Andrew White of John Carroll University included samplings at Rockside Road and the base of the falls in Peninsula. Fishes collected included the white sucker, golden shiner, emerald shiner, blacknose dace, creek chub, silverjaw minnow, fathead minnow, stoneroller, goldfish, stickleback, green sunfish, bluegill, and black bullhead. The physical appearance of several of these fish indicated that they represented a true riverine population and were not accidental strays washed into the river from adjacent lakes, ponds or tributaries. Most fishes collected were hardy species with rather broad ranges of tolerance. This represents a change from earlier 1968 studies in which no fish at all were recorded below Akron.

A complete listing of species, habitats, and sampling techniques can be obtained from two surveys: first, "Ecological Monitoring of the Cuyahoga River," prepared for the Buffalo District by Dr. John Olive of the University of Akron; second, "The Technical Report for the Cuyahoga River Valley Park Study," prepared for Ohio Department of Natural Resources by private consultants.

(2) Vegetation - Today, only vestiges of the presettlement vegetation of the Cuyahoga River Valley and surrounding areas exist; having been disturbed by agriculture, canal, and road development. This intensive human activity (except in remote areas) has disrupted the natural climax community structure, thus allowing for a wide variety of species. Dr. John Olive (1974) conducted an ecological study of the Cuyahoga in 1973-74 and his findings show that terrestrial vegetation at nearly all sample stations consisted of early pioneer annuals or early successional shrubs. Only one sample area consisted of a flood plain forest (Standing Rock Cemetary).

In a study conducted for the State of Ohio's Department of Natural Resources, Division of Outdoor Recreation (Ohio Department of Natural Resources (ODNR), 1975), 14 Landscape types, including nine vegetation types and five types with little or no vegetation, were identified in the Cuyahoga Valley. These are shown in Table 2.

Forest stands of the Cuyahoga Valley Region were classified as representations of the major types listed in Table 3. Approximately 40 percent of the region is forested and this consists primarily of second growth stands of mixed hardwoods that vary widely in composition, and represent several of the original forest types. Scattered, relict stands of hemlock and white pine forest persist throughout the region, and remnant beech-maple forests can be found on upland plateaus.

A flora survey in the "Cuyahoga Valley, 1975" study, show that 987 species occur in the Cuyahoga and Summit County area. This represents approximately 43 percent of the vascular flora types found in Ohio. Figure 5 represents a transect of typical valley vegetation (ODNR, 1975:20).

Table 2 - Landscape and Vegetation Types - Cuyahoga Valley

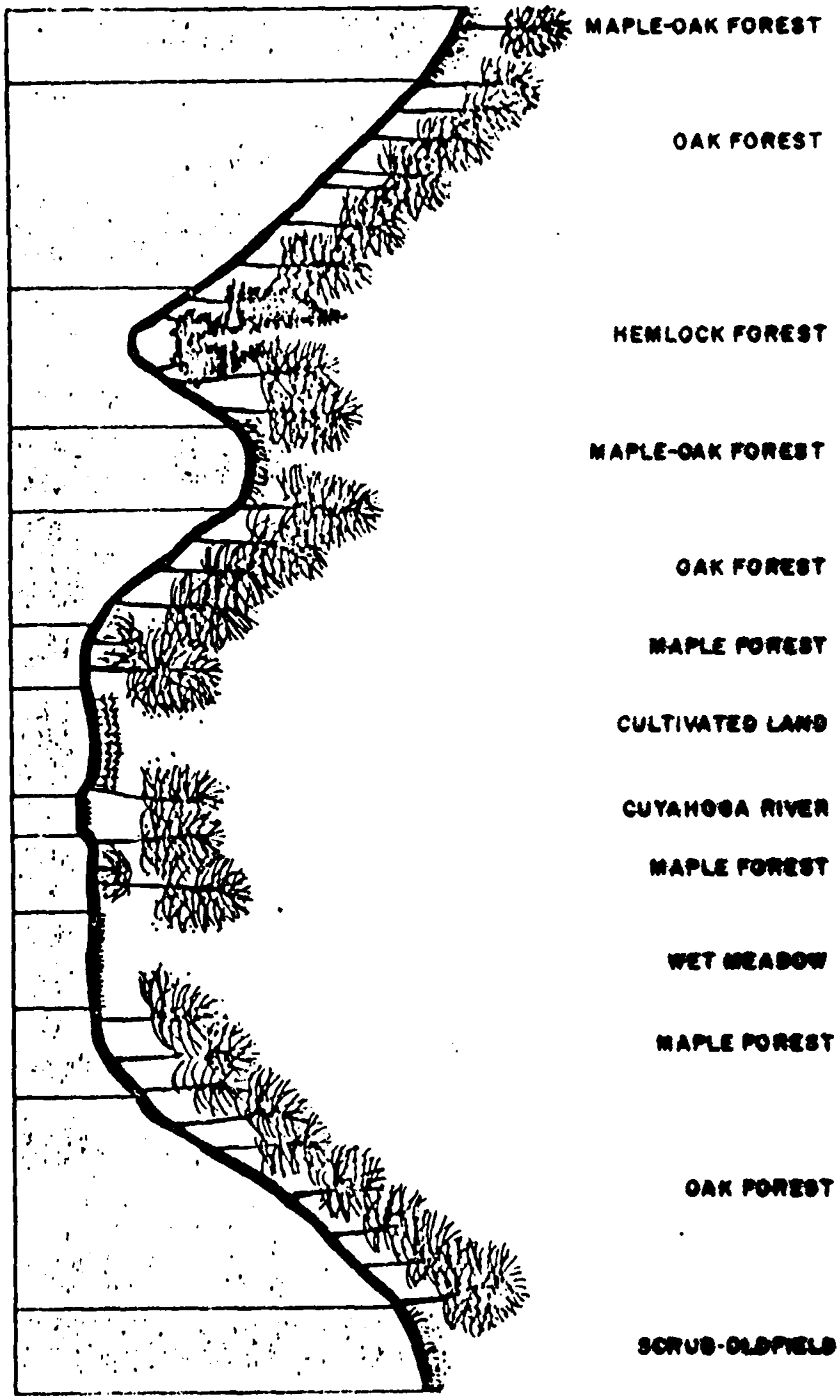
Type	% Coverage of Region by Subtype	% Coverage of Type for Total Region
A. Natural Vegetation Subtypes		69
(1) Oak Forest	22.1	
(2) Oldfield	16.3	
(3) Scrub	12.0	
(4) Maple-oak forest	10.5	
(5) Maple-sycamore forest	4.2	
(6) Beech-oak forest	2.4	
(7) Pine forest	1.0	
(8) Meadow	0.3	
(9) Hemlock forest	0.2	
B. Suburban Land		17.9
C. Roads and Water		10.0
D. Cultivated Land		2.4
E. Orchard		0.3
F. Barren Land		0.4
		31
Total		100

(ODNR Data)

Table 3 - Forest Types/Vegetation Categories
Based on Canopy Species Composition

No.	Forest Type
1	Oak Forest
	a. White oak or mixed oaks (on upland plateaus)
	b. Mixed oaks and hickories (on steep slopes)
	c. Oaks, tuliptree, basswood, maple, beach (On lower areas of steep slopes joining the flood plain of the Cuyahoga River)
2	Maple-oak Forest
	a. Red maple, oaks, and hickories
	b. Scrub-forest (greater than 20 feet in height) with ash, elm, red maple, black locust, and black cherry
3	Maple-sycamore Forest
	a. Sycamore and willow
	b. Black maple, sycamore, slippery elm, walnut, tuliptree, basswood, and cottonwood
	c. Black maple, sycamore and tuliptree
4	Beech-oak Forest
	a. American beech, white oak and tuliptree
	b. American beech, white oak and sugar maple
	c. American beech, white oak, tuliptree, basswood, and black maple
5	Hemlock Forest
	a. Hemlock
	b. Hemlock and beech
6	Pine Forest
	a. Pine
	b. Spruce
	c. Pine and spruce

From: (ODNR, 1975:21)



SOURCE:
"CUYAHOGA VALLEY [illegible]" - PAGE 80

CUYAHOGA RIVER, OHIO
RESTORATION STUDY
TRANSECT OF TYPICAL
VALLEY VEGETATION
WITHIN CUYAHOGA VALLEY

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979

FIGURE 5

(3) Wildlife - In 1974 a wildlife survey was conducted by Jack McCormick & Associates, Inc. (ODNR, 1975) as part of a joint effort to study that portion of the Cuyahoga Valley bounded by Interstate Route 77 on the west, Rockside Road on the north, Ohio State Route 8 on the east; and an arbitrary line approximately 2,000 feet south of Bath Road on the south (see Figure 6). The study results revealed a total of 310 species, listed in Table 4.

(4) Game Animals - The cottontail rabbit (*Sylvilagus floridanus*) density, as rated by Ohio Department of Natural Resources Division of Wildlife, ranges from 200 to 400 per square mile, primarily in the cropland-oldfield habitat types. Also typical of this habitat, but occurring in relatively low numbers are the ring-necked pheasant (*Phasianus colchicus*), at less than seven birds per square mile, and the bobwhite quail (*Colinus virginianus*), at less than ten coveys or 150 birds per square mile.

White-tailed deer (*Odocoileus virginianus*) populations were estimated in 1973 as being about 0.5 deer per square mile of area in Cuyahoga and Summit Counties (U.S. Environmental Protection Agency (USEPA), 1976). The wooded areas of the Cuyahoga Valley, which are undeveloped for the most part, have served as the reservoir from which deer populations have expanded. There are approximately two fox squirrels (*Sciurus nigra*) per acre of woodlot in the Cuyahoga Valley. Gray squirrels (*Sciurus carolinensis*) occur in smaller numbers and are concentrated in the larger woodlots and around cities and parks. Black squirrels (a melanistic variety of the gray squirrel) are also found in park and residential areas.

The Cuyahoga Valley falls on the western edge of the secondary range of the ruffed grouse (*Bonaea umbellus*). There exist isolated breeding populations despite the pressures of urbanization in the region.

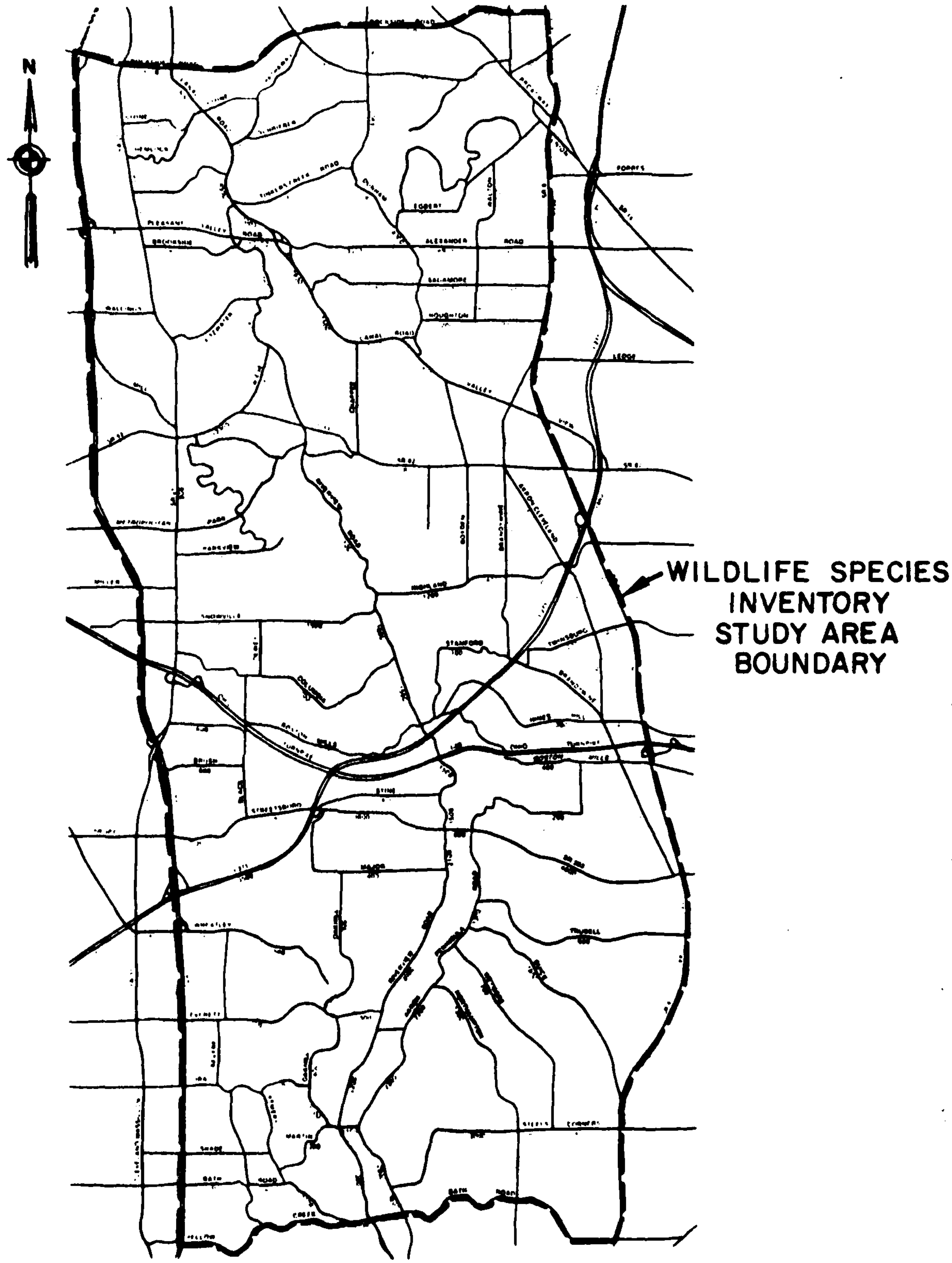
A nominal wild turkey (*Meleagsis gallopaus*) population occurs mostly within the proposed Cuyahoga Valley National Recreation Area (USEPA, 1976).

The Cuyahoga River is considered an excellent wood duck (*Axis sponsa*) producing area. This duck is Ohio's most populous species accounting for about one-third of the annual waterfowl kill.

Twelve wildlife habitat types were recognized as follows: pond and lake, stream and river, meadow, lowland forest, ravine forest, upland deciduous forest, upland coniferous forest, scrub, orchard, oldfield, and cropland, barren land and suburban land.

Habitats were compared in terms of species composition, importance to threatened and endangered species, and use by species that exhibit restricted habitat affinities. Ravine and lowland forest were found to support the greatest number of breeding species.

The extensive areas of forest and aquatic environments in the Cuyahoga River Valley constitute a substantial portion of the habitats available for many species of game and furbearers in an otherwise heavily developed section of the State. Hunting, trapping and aesthetic enjoyment of the wildlife resources are considered important traditions in the area.



SOURCE:
"CUYAHOGA VALLEY 1975" - PAGE 33

CUYAHOGA RIVER, OHIO
RESTORATION STUDY
WILDLIFE SPECIES
INVENTORY
STUDY AREA BOUNDARY MAP

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979

FIGURE 6

Table 4 - Cuyahoga Valley Wildlife Species Inventory

Fauna	Number of Species	Birds: Permanent Resident	Birds: Transients Season Resid. Visitants	Game Animals	Fur-Bearers
Mammals	41			32	9
Birds	228	59	169		
Reptiles	18				
Amphibians	23				
Total Species	310				

(ODNR Data)

(5) Threatened and Endangered Species - This phrase, as set forth by the Endangered Species Act, 1973, P.L. 93-205, usually describes all species whose survival is considered to be in immediate or potential jeopardy. Specific categories of endangerment are defined as follows:

(a) Endangered - a species whose survival is in immediate jeopardy

(b) Threatened - a species not presently facing extinction but which may become endangered if conditions favoring its survival deteriorate

The official State and Federally adopted lists and amendments include several species known to be resident, breeding or migratory in Ohio (Haney, 1977) (U.S. Fish & Wildlife Service (USFWS), 1977).

Table 5 reflects those endangered species that are reasonably likely to occur in the Cuyahoga River Watershed throughout a four season period (Haney, 1977) (USF&WS, 1977). Table 6 contains a partial list of species in the valley which are presently known to be threatened or declining in population (CRSD, 1976).

The bald eagle (*Haliaeetus leucocephalus*) is the one species classified by the U.S. Fish and Wildlife Service as endangered that would occur in the study area, and then only as a migrant or transient. The sharp-shinned hawk (*Hecipiter striatus velox*) winters in the valley and is noted as a possible breeder, however no recent nests have been reported (CRSD, 1976).

The American peregrine falcon (*Falco peregrinus anatum*) and the Kirtland's warbler, (*Dendrocia* kirtlandi) are known to migrate through this area in the spring and fall. The Indiana Bat (*Myotis sodalis*) is known as a summer resident in southeast Ohio and can be expected to appear in the Cuyahoga Valley. The general lack of caves probably precludes hibernation of this species in the area.

There is a breeding population of the Spotted salamander (*Ambystoma maculata*) along Sagamore Road on the Hawthorn trunk sewer. This is the only known breeding colony in the Cuyahoga Valley. The size and extent of this community is unknown and would have to be determined prior to an evaluation of the worth of protective measures which may be necessary.

The State of Ohio does not maintain a list of endangered species of plants protected by law. The Federal Government is presently studying a proposed list of plant species for protection by law throughout the United States (USFWS, 1976). There are only two species from that list that occur in Ohio, Heart-leafed Plaintan (*Plantago cordata*) and Spreading Globeflower (*Trollis laxus*).

c. Human Environment

(1) Cultural Resources

(a) Prehistory - Although few systematic surveys have been done in the Cuyahoga River Basin, existing data indicates that the area has been

Table 5 - Endangered Species Likely to Occur in Study Area

Species	Ohio Protected	U. S. Protected
Mammals		
Myotis sodalis - Indiana bat	X	X
Birds		
**Falco peregrinus anatum* - American peregrine falcon	X	X
**Haliaeetus leucocephalus* - Bald eagle	X	X
Accipiter striatus velox - Sharp-shinned hawk	X	
**Sterna hirundo* - Common tern	X	
Bartramia longicauda - Upland sandpiper	X	
**Dendroica kirtlandi* - Kirtland's warbler	X	
Reptiles		
Clemmys guttata - Spotted turtle	X	
Amphibians		
Ambystoma laterale - Blue-spotted salamander	X	
Hemidactylium scutatum - Four-toed salamander	X	
Fish		
Erimyzon succtta - Lake chubsucker	X	
Etheostoma exile - Iowa darter	X	

* Would occur as a migrant or transient only.
From: (Haney, Dale, 1977)

Table 6 - A Partial List of Threatened or Declining Species in the Study Area

Threatened	
Spotted Turtle	Upland Sandpiper
Smooth Green Snake	Barn Owl
Great Egret	Short-billed Marsle Wren
Least Bittern	Loggerhead Shrike
Hooded Merganser	Prothonotary Warbler
Cooper's Hawk	Orchard Oriole
Osprey	
Declining in Population	
American Bittern	Cliff Swallow
Pied-billed Grebe	Purple Martin
Red-shouldered Hawk	Long-billed Marsle Wren
*Ring-necked Pheasant	Warbling Vireo
Virginia Rail	Bobolink
Common Gallinule	Northern Oriole
Black Tern	Grasshopper Sparrow
Screech Owl	Henslow's Sparrow
Whip-poor-will	Swamp Sparrow
Rough-winger Swallow	

* Introduced species, adventive
From: CRSD, 1976:44

inhabited since sometime after the retreat of the last glacial ice around 13000 B.C. This long period of occupation is usually divided into three major time blocks that loosely correlate with cultural changes.

During the Paleo-Indian period, approximately 13000 B.C. to 8000 B.C., small groups of hunter-gatherers roamed within loosely defined territories in search of game. Although most of the knowledge of their existence in the Cuyahoga area comes from discoveries of their distinctive projectile points, it is known that they hunted extinct game such as mastodon, giant moose, and giant beaver, as well as, modern species then occupying the area.

The subsequent Archaic Period lasted until about 1500 B.C. and was characterized by increasing populations, that began utilizing smaller areas more intensively. Within the Cuyahoga Valley National Recreation Area these people "lived part of the year on bluffs overlooking the secondary tributaries (like Furnace Run and Brandywine Creek), and seasonally occupied smaller hunting camps in rock shelters and at heads of drainages (Brose 1975:3)" (National Park Service (NPS), 1976:58).

The Woodland period is usually subdivided into three parts; the Early Woodland (1500 B.C.-100 B.C.), Middle Woodland (100 B.C.-A.D. 700) and the Late Woodland (A.D. 700-A.D.1600). The presence of pottery on Early Woodland sites is one of the primary factors distinguishing these sites from late Archaic sites. It was during the Early Woodland period that corn, bean, and squash agriculture began. Villages of this period are also associated with earthen burial mounds containing exotic grave goods (Bush 1976:G-6).

The Middle Woodland period is marked by larger more permanent villages and an increase of trade between northern Ohio and other parts of eastern North America. This is the period when the Hopewell Culture flourished in southern Ohio, and their influence is seen in some of the artifacts on Middle Woodland sites in the Cuyahoga Basin. Early and Middle Woodland "village sites have been found along forest-floodplain edges on Furnace Run, Dickerson Run, and Chippewa Creek; burial mounds are generally located along the lower edges of the steep river bluffs" (NPS, 1976:58).

During the Late Woodland period northeastern Ohio, including the Cuyahoga, was occupied by people whose sites have been placed in the Whittlesey Focus. The following model of the Whittlesey settlement patterns and subsistence activities has been proposed by David Brose (Brose 1976:43-44).

A.D. 900-A.D. 1300, small agricultural villages were established in the interior drainage basin uplands and along the Lake Erie Coastal Plain. During the fall, smaller camps were set up on the coastal plain. These camps were used for hunting migratory water fowl and catching fall-spawning fish. Winter camps were very small and were located on ridges adjoining the lake plain and the interior uplands. Early spring coastal fishing camps brought the scattered villagers back together again.

A.D. 1250-A.D. 1450, agricultural villages were established on the coastal plain and in the interior uplands and were occupied from late spring through autumn. The remainder of the year, lakeside villages were used. Small short-duration special purpose sites were located throughout the basin.

A.D. 1400-A.D.1600, large usually fortified year-round agricultural villages were located in the interior uplands bordering major river valleys. During this period, there were numerous hunting and butchering stations along the valleys and into the interfluvial plateau region. The only lakeside occupation was at small campsites for the collection of fish and/or migratory waterfowl.

(b) History - There are no sites in the area that can be dated to the period from 1640 to 1720 and the reasons for the apparent abandonment of the region are still unknown. During the 18th century, the area was visited by explorers, traders, and missionaries. It was not until treaties signed in 1784 and subsequently, established the Cuyahoga, Portage Path, and the Tuscarawas as the boundary between Indian and white territory that the area began to be permanently settled.

A group of Moravians lived near Valley View for a short period around 1785. The Connecticut Land Company bought a large tract of land including most of the Cuyahoga Valley and in 1796, Moses Cleveland surveyed the area around Cleveland and a city plan was developed. The opening of the Erie Canal made settlement of the area much easier and enthusiasm for canal building led to the construction of the Ohio and Erie Canal. The first section between Cleveland and Akron opened in 1827, and allowed boats to travel the 37 miles through 42 locks (NPS, 1976:61). Settlement of the area progressed rapidly and Peninsula became a thriving town.

The popularity of canals waned with the increased construction of railroads but it was not until 1880 that a railroad connected Cleveland and Akron. The canal continued in use until 1913 when a flood destroyed several locks. The canal was officially closed in 1924.

(c) Existing Data - Although the Cuyahoga Valley has not been systematically surveyed, over 100 prehistoric sites have been recorded in the area. These represent only a fraction of the sites which are believed to exist in the valley. The Cuyahoga Valley National Recreation Area has been surveyed for historic sites and information about these sites can be obtained from the Western Reserve Historical Society. The Historic American Engineering Record has been involved with several surveys of historic structures in Cleveland and is planning a survey of the Cleveland waterfront. Numerous sites in the Cleveland-Akron area have been nominated to the National Register of Historic Places and portions of the Ohio and Erie Canal, including the Tinkers Creek aqueduct are National Historic Landmarks.

(2) Recreation - In 1975, Ohio developed a Comprehensive Outdoor Recreation Plan which forcasted needs for 18 recreational activities. The plan made projections for the years 1975, 1980, and 1990. The Cleveland area had the highest projected needs in the State for 16 of the 18 activities. The Cuyahoga River Valley received the highest ranking of any identified potential resource area in the region. In the late 1960's the State of Ohio

and the Cleveland and Akron Metropolitan Parks Districts initiated efforts to acquire property in the Cuyahoga Valley.

As a result of these efforts to preserve the Cuyahoga Valley, the Cuyahoga Valley National Recreation Area (CVNRA) was established in 1974 by Public Law 93-555 "for the purpose of preserving and protecting for public use and enjoyment, the historic, scenic, natural, and recreational values of the Cuyahoga River and the adjacent lands of the Cuyahoga Valley and for the purpose of providing for the maintenance of needed recreational open space necessary in the urban environment..." Management of the CVNRA is the responsibility of the National Park Service.

The recreation area will eventually incorporate approximately 29,100 acres and is shown in Figure 7. Approximately 45 percent of this area is already devoted to recreational land use. Table 7 lists these areas and their acreage.

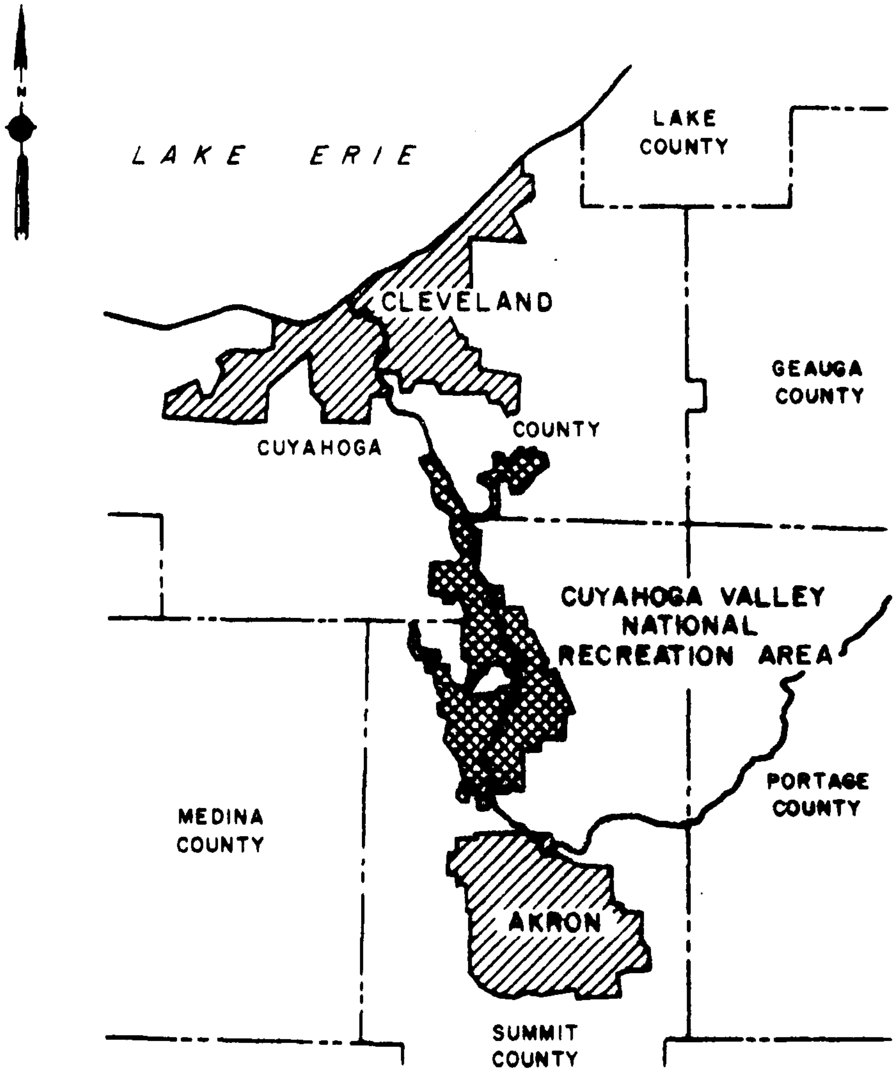
In addition to the areas within the boundaries of the CVNRA, there are several other public recreation facilities in the study area. The Cleveland Metropolitan Park District's famous Emerald Necklace (eleven park reservations and connecting parkways) includes roughly 18,000 acres and 84 miles of park drives. Arrangements are being made to transfer ownership of several of the lakeshore parks to the State Department of Natural Resources. The Akron Metropolitan Park District administers over 6,000 acres. The metroparks provide a variety of day-use activities in both natural and historic settings. Punderson State Park, near the head waters of the Cuyahoga, provides a variety of recreational activities.

Additionally, there are numerous quasi-public and private recreational facilities in the project area. These facilities will be more precisely documented if it appears that any of the proposed alternatives might affect their use.

(3) Aesthetics - The aesthetic qualities of the Cuyahoga River Valley vary from a developed commercial harbor; to a wooded valley with rugged slopes; to an urban area; to open rolling agricultural lands with large wooded expanses.

From the mouth of the river to slightly upstream of the limits of commercial navigation, the Cuyahoga is generally dominated by visual closure. The docks, industrial plants, warehouses, and other facilities that border the river create a visual corridor. The river bluffs and urban developments beyond the bluffs add emphasis to the corridor perception, particularly along the middle section of the Cuyahoga where the central business district skyline is especially visible. The view of the river corridor is dynamic in that its visual elements (structures, docks, ships, etc.) continually change as the view progresses upriver along the winding river channel (COE, Buffalo, 1976:94).

The rugged topography of the area to be incorporated into the Cuyahoga Valley National Recreation Area provides varied and generally open vistas of relatively undeveloped natural areas. Cleared corridors for gas and oil pipelines, electrical power transmission towers, and land scars from existing and



SOURCE:
"CUYAHOGA VALLEY 1975" - PAGE 8

CUYAHOGA RIVER, OHIO
RESTORATION STUDY

CUYAHOGA VALLEY NATIONAL RECREATION AREA LOCATION MAP

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979

FIGURE 7

Table 7 - Existing Recreation Areas Within the Boundaries of the Cuyahoga Valley National Recreation Area

	Acres
PUBLIC RECREATION	
Akron Metropolitan Parks	
1. Virginia Kendall	460
2. Hampton Hills	330
3. Deep Lock Quarry	166
4. Furnace Run	832
5. O'Neil Woods	240
6. Other	414
Cleveland Metropolitan Parks	
1. Brecksville Reservation	2,760
2. Bedford Reservation	1,334
Hudson Township	
1. Wildlife Woods	60
State Owned	
1. Virginia Kendall	1,633
2. Other	1,709
Total Public Recreation	9,938
QUASI-PUBLIC RECREATION	
1. Blossom Music Center	810
2. Camp Manatoc and Camp Butler	607
3. Camp Ledgewood	472
4. Camp Mueller	193
5. Camp Onlofte	19
6. Hale Farm and Village	186
7. Akron Optimist Club Camp	10
8. Kiwanis Club Camp	5
9. Stumpy Basin	35
10. City of Akron	67
Total Quasi-Public Recreation	2,404
PRIVATE RECREATION	
1. Brandywine Country Club	167
2. Brandywine Ski Area	215
3. Boston Mills Ski Area	88
Total Private Recreation	470
TOTAL PARK AND RECREATION	12,812

(ODNR, 1975:48)

abandoned quarries are visual intrusions which occur throughout the river basin. Open dumps along roadsides and ravines are also numerous in the park and represent an unsightly practice.

Two highway bridges crossing the valley (Ohio Turnpike and I-271), provide major existing visual intrusions. A third bridge, that of Route 82, also crosses the valley, but is considered by some as visually appealing due to its arched construction (NPS, 1976:56).

In many park locations the quality of the aesthetic environment is, however, well maintained. One such place is the Tinkers Creek Gorge located in the Bedford Metropark. Another is the undeveloped area of the Pinery Narrows (NPS, 1976:57).

Towards Akron the river valley is more urbanized and there are several dams and reservoirs, often associated with parks. This provides contrasting scenes from quiet ponds to waterfalls. Upstream of the Akron area the land becomes flatter and there are several more reservoirs. The river flows through an essentially rural area and there is abundant streambank vegetation.

(4) Transportation - The Cuyahoga River Basin contains land, air, and water transportation facilities. Annually, Cleveland Harbor handled an average of 22,886,000 tons of material from 1965 to 1974. Ninety percent of this consisted of stone and iron ore (COE, Buffalo 1976:52). Cleveland and Akron are served by major trunk lines of the Consolidated Railway Corporation, the Chessie System, and the Norfolk and Western Railroad Company. The rail line through the Cuyahoga Valley between Akron and Cleveland was acquired by the B&O (now part of the Chessie System) in 1915.

The area is connected to the rest of the State and country by several interstates and Federal highways. Highways of arterial quality parallel the river on both rims of the Cuyahoga Valley. East-west corridors are somewhat limited with concentrations in the Cleveland and Akron areas. Pleasant Valley/Alexander, SR 82 and SR 303 are primary corridors across the CVNRA. The Ohio Turnpike (I-80) and I-271 cross the park on high level bridges.

Cleveland-Hopkins Airport, Burke-Lakefront Airport, and Akron-Canton Regional Airport provide commercial air service to the area. Additionally there are several smaller private airfields in the study area.

Numerous oil and gas pipelines cross the region, serving local needs and supplying the refineries upstream of the Federal Harbor limits on the Cuyahoga. Seventeen miles of pipeline occur within the boundaries of the CVNRA (NPS 1976:56).

(5) Utilities - The communities along the Cuyahoga between Akron and Cleveland are served by a variety of county, city, and village sewage treatment plants and private systems including septic tanks. New development has been limited in recent years by the lack of adequate sewerage in the central part of this area. The Cleveland Regional Sewer District is in the process

of planning interceptors that would eventually service the area from Garfield Heights on the north, to Tinkers Creek on the south. The material collected by this system would be processed at the Cleveland Southerly Sewage Treatment Plant.

The majority of this area is served by the Cleveland Water Department with water lines on the east side of the valley extending as far south as Northfield Center Township. Akron water extends northward into the southeastern corner of Northampton Township and also north of Cuyahoga Falls. The lack of sewer and water service for the undeveloped portions of Richfield-Bath Townships are limiting factors to growth in these areas.

Natural gas is provided to the area by the East Ohio Gas Company, which supplies gas fuel to an area of some 2,500 square miles, and has over 930,000 customers. The Ohio Bell Telephone Company provides telephone services to over 3.6 million people, including the entire project area. The Cleveland area is serviced by the Cleveland Electric Illuminating Company and the Akron area is serviced by Ohio Edison.

(6) Noise - No extensive noise measurements exist for the Cuyahoga Valley between Cleveland and Akron. In 1970, the Cleveland Standard Metropolitan Statistical Area (SMSA) had registrations of 527 motor vehicles per 1,000 population, and 10 motorcycles per 1,000 population; a recent USEPA publication used this incidence of vehicle registration as an index of noise pollution, the Cleveland SMSA ranking 25th and 9th lowest, respectively, among 65 SMSA's with population over 50,000. The Akron SMSA with vehicle registrations of 563 per 1,000 and 15 per 1,000, ranked 37th and 28th lowest, respectively. Cleveland Hopkins Airport, the principal Cleveland commercial airport, is located in the northwest portion of the Basin and is close enough to have some impact under certain takeoff and landing conditions. (CRSD, 1976:2-49).

Natural sources of noise in the Cuyahoga Valley provide a background for the visitor's experience. The rivers and streams of the area frequently do not generate noise, but periodic waterfalls and small rapids manifest the dynamic forces that continually mold and remold the region's profile. The occurrence of these sounds--regardless of how loud--is acceptable and even desirable as part of the total environment. (NPS 1976:37).

(7) Land Use - For approximately six miles upstream of the mouth of the Cuyahoga, the river channel is maintained by the Corps of Engineers for purposes of commercial navigation. The valley in this area has been intensively developed and the river is lined with industrial plants, warehouses, commercial offices, and dock and terminal storage facilities. Land use in this area is discussed in more detail in the "Revised Draft Environmental Impact Statement for the Feasibility Report for Harbor Modification, Cleveland Harbor, Buffalo District," (June 1976).

Upstream from the upper limits of commercial navigation to the boundaries of the Cuyahoga Valley National Recreation area (CVNRA), land use is mixed residential, commercial, industrial, and agricultural. Only 3.6 percent of Cuyahoga County is farmland (COE, Buffalo, 1976:71). Within the CVNRA only seven percent of the total acreage is developed and of this 2.5 percent is residential. Transportation corridors account for another 3.2 percent. Commercial, industrial, and public and quasi-public development totals approximately 0.7 percent. Prior to its designation as a National Recreation Area, 45 percent of the land within the park had been acquired by public, quasi-public and private interests for recreational use. Although about 46 percent of the land is undeveloped, only a relatively small amount is farmed.

Land use, zoning, and development are discussed in detail in the Environmental Assessment for the general management plan for the Cuyahoga Valley National Recreation Area, October 1976.

(8) Socio-Economic - The Cuyahoga River Basin encompasses the Akron SMSA (Portage and Summit Counties) and part of the Cleveland SMSA, (Cuyahoga and Geauga Counties). The total population in the Cuyahoga River Basin in 1970 was 2,463,516 (see Table 8). About 93 percent of the people live in urban areas while the rural areas accounted for only about seven percent of the population. Cleveland, the largest city in the basin, had a population of 750,903 in 1970. Akron, the second largest city, had 275,425 people.

In 1970, 93 percent of the population in the Cuyahoga River Basin was urban but this may be changing because the 1975 estimates (Bureau of Census (BOC) 1977:80-81) indicate that the urban areas are losing population (see Table 8). The percentage change for the basin was a negative five percent in 1975. This contrasts with a projected 9.2 percent increase for the period 1970 to 1980 (COE, Buffalo, 1971:12). If the 1975 estimates are correct and this trend continues, the population projections for the Cuyahoga River Basin will have to be recalculated to reflect significantly lower growth rates.

Several socio-economic factors are presented in Table 9 allowing comparison between the four-county area and the State of Ohio. Cuyahoga County has a significantly higher percentage of non-whites than the State as a whole. Geauga and Portage Counties have significantly lower percentages. The statistics for Cuyahoga and Summit Counties are relatively similar, partially due to the influence of Cleveland and Akron. Data in the environmental assessment of the Cuyahoga Valley National Recreation Area indicate that this area is inhabited by a primarily white, middle-age group with 29.4 percent professional and administrative workers (NPS 76:75).

(9) Housing - One and two family residences predominate and account for 93 percent of all the housing units within the area. Most of these are one family units comprising 91 percent of the total. Owner-occupied units represent 85 percent of the total units. Vacancy rates are low, averaging less than three percent.

Table 8 - Population by County in the Cuyahoga River Basin, State of Ohio, and United States - 1970 and 1975 Estimate

County	Total 1960 County Population	Total 1970 County Population	Percent Change 1960-70	1 Jul 75 Estimate	Percent Change 1970-75	1970 Urban	1970 Rural
Cuyahoga	1,647,895	1,721,300	4.5	1,603,900	-6.8	1,714,886	6,414
Geauga	47,573	62,977	32.4	67,300	6.9	9,181	53,796
Portage	91,798	125,868	37.1	132,900	5.6	67,636	58,232
Summit	513,569	553,371	7.8	535,300	-3.3	500,236	53,135
Total	2,300,835	2,463,516	7.1	2,339,400	-5.0	2,291,939	171,577
Ohio	9,706,397	10,652,017	9.7	10,759,000	1%	8,025,697	2,626,320
U. S.	179,323,175	203,165,573	13.3			149,280,769	53,884,804

(BOC, Data)

Table 9 - Comparative Socio-Economic Data from the 1970 Census

	State of Ohio	Cuyahoga County	Geauga County	Portage County	Summit County
Total Population	10,652,017	1,721,300	62,977	125,868	553,371
Percent Non-White	9.4	19.6	1.5	2.5	9.3
Percent Over 65	9.4	9.8	6.3	6.1	9.2
Percent Under 18	35.1	33.2	34.2	29.2	34.9
Median Age	27.7	29.7	25.7	22.6	28.1
Median Family Income	10,313	11,309	12,411	10,992	11,058
Employed Labor Force	4,063,730	695,800	23,807	47,306	212,757
Percent of Total Population	38.0	40.4	37.8	37.6	38.4
Percent Professional & Administrative	21.3	22.8	25.2	22.4	22.8
Percent Farm Workers	1.7	0.3	2.6	1.6	0.3
Percent All Others	77.0	76.9	72.2	76.0	76.9

(BOC Data)

(10) Business & Industry - Within the boundaries of the CVNRA there were 39 employers, employing an average of 538 people in 1974 (NPS 1976:77). This is only a small fraction of the employers in the four-county area, many of which are concentrated in the Cleveland and Akron Urban areas. The value added by manufacturing in 1970 in Cleveland was in excess of $4 billion. Products manufactured in the Cleveland area include steel, automotive products, machine tools, petroleum products, chemicals, rubber goods and wearing apparel. Akron is world famous as a major tire and rubber center.

9. PROBLEMS, NEEDS, AND OPPORTUNITIES

a. General - Erosion and sedimentation problems are a real concern to the residents of the Cuyahoga River Basin. Erosion of stream channels and land surfaces feeds large quantities of sediments to the river where it impairs water quality, aggravates flooding problems, depresses oxygen levels, and alters aquatic life. These problems have become more significant in recent years with the establishment of the Cuyahoga Valley National Recreation Area and its emphasis on scenic enjoyment of the river valley.

In general terms, the Cuyahoga River between Independence (river mile 13.8) and Old Portage (river mile 40.25) can be classified as a meandering stream with many unstable reaches. Present conditions are probably not greatly different than those of hundreds of years ago, since the name of the river may have been derived from Indian words for "crooked." In addition, names of tributaries such as Mud Brook, Yellow Creek, and Sand Run indicate an early history of natural influences on water quality. The main differences at present appear to be largely due to increased erosion due to man-made disturbances such as highway and building construction activities, surface mining operations, cropping and timbering practices which remove the protective vegetation covering, etc. Photographs 1 through 5 illustrate examples of these problems. Photograph 6 shows bank erosion near Jaite and an attempt at controlling that erosion.

b. Expressed Public Concerns - A public hearing was held on 16 September 1970 in Cuyahoga Falls, Ohio, to solicit public comment on the proposed survey of the "Cuyahoga River from Upper Kent to Portage Trail in Cuyahoga Falls, Ohio, in the interest of flood control, pollution abatement, low flow regulation, and other allied water purposes" under the authority of the 1968 Flood Control Act. The views expressed at this public hearing are considered representative of the basin, as those that were present included a sampling of the entire watershed. Requests made at this hearing included, among other things, a program for debris removal, and streambank stabilization in the river system. As previously discussed in paragraph 2, comments made at this meeting led to expansion of the scope of the study to include among other things, "...bank stabilization by vegetation and other means" under the authority of Section 108 of the 1970 River and Harbor Act.

During its review of the "First Interim Report" for the Cuyahoga River Restoration Study, the Board of Engineers for Rivers and Harbors (BERH) concluded, among other things, that a settling basin on the Cuyahoga River should also be considered as an early-action program. Accordingly, the Board conducted a public meeting on 19 January 1972, in Cleveland, Ohio, on the

Photo 1 - Encroachment from apartment development
(Cuyahoga River 1978.)

Photo 2 - Construction debris dumped in Furnace Run (1978.)

Photo 3 - Bank erosion next to a cropfield (Cuyahoga River 1978.)

Photo 4 - Erosion of the land surface in a cropfield after harvesting (Cuyahoga River 1978.)

Photo 5 - Surface mining of gravel and fill material
(Mud Brook 1978.)

Photo 6 - Bank erosion with autos providing erosion
control (Cuyahoga River 1971.)

considered modifications. Based on the information presented at this meeting, the Board concluded that local interests were not prepared at that time to provide the required items of local cooperation for the settling basin and noted that substantial environmental issues would have to be resolved before implementing the plan. Local interests also stated their desire for the Corps of Engineers to conduct a detailed basin-wide survey to identify and quantify sources of sediment and to formulate plans of improvements to control erosion at its source rather than at the downstream reach of the river. The Board, therefore, recommended that a settling basin on the Cuyahoga River be given further study and be considered for construction if the environmental issues could be resolved and the items of local cooperation met.

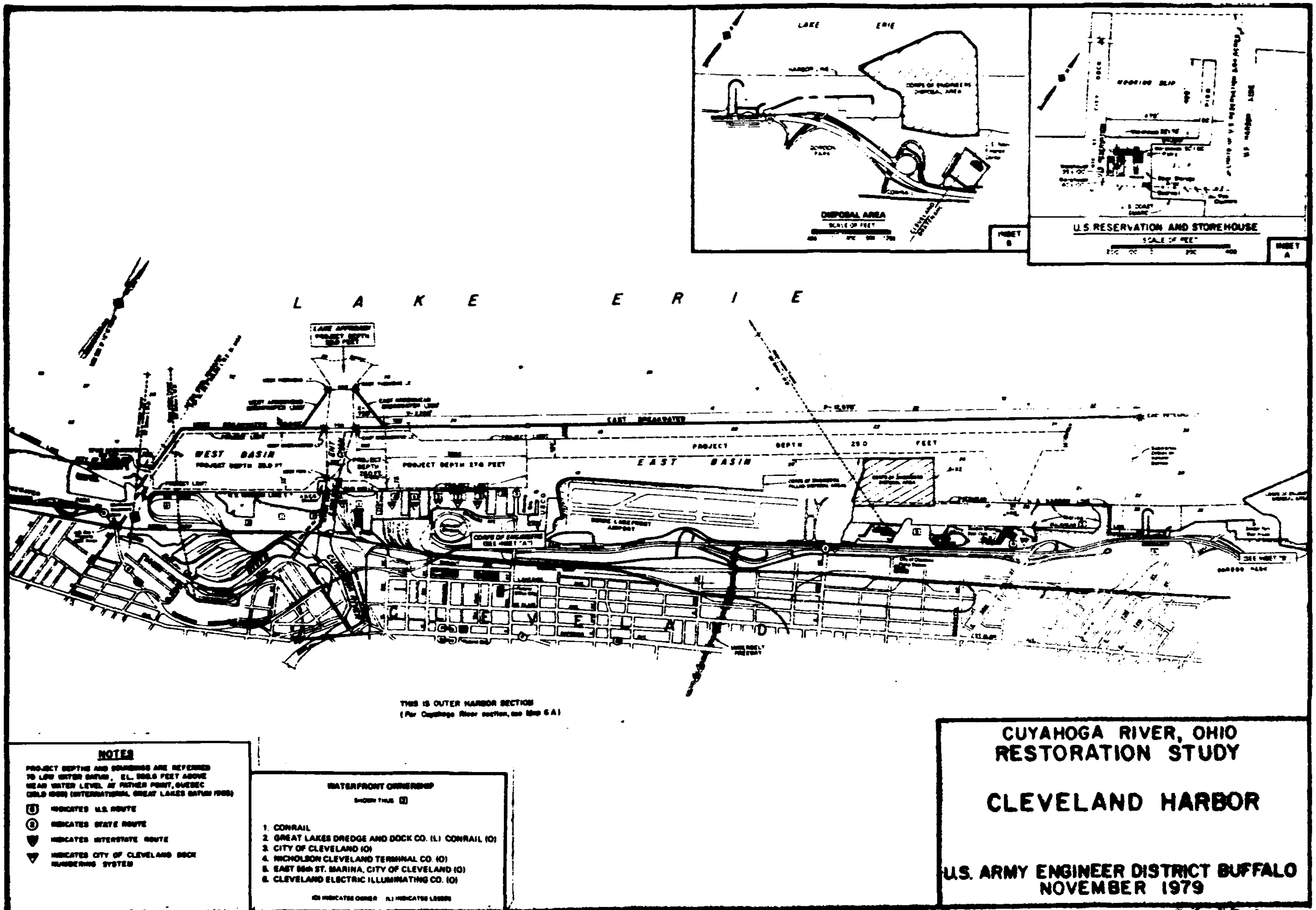
As previously discussed in paragraph 5, workshop meetings were held with study participants on 18 August 1976 in Columbus, Ohio, and on 19 August 1976 in Cleveland, Ohio, to obtain their views regarding the remainder of the Cuyahoga River Restoration Study. The consensus of opinion was that the most critical remaining study objective was erosion and sedimentation. In particular, the identification and control of the most prolific sources of sediment entering the Cuyahoga River would be highly desirable.

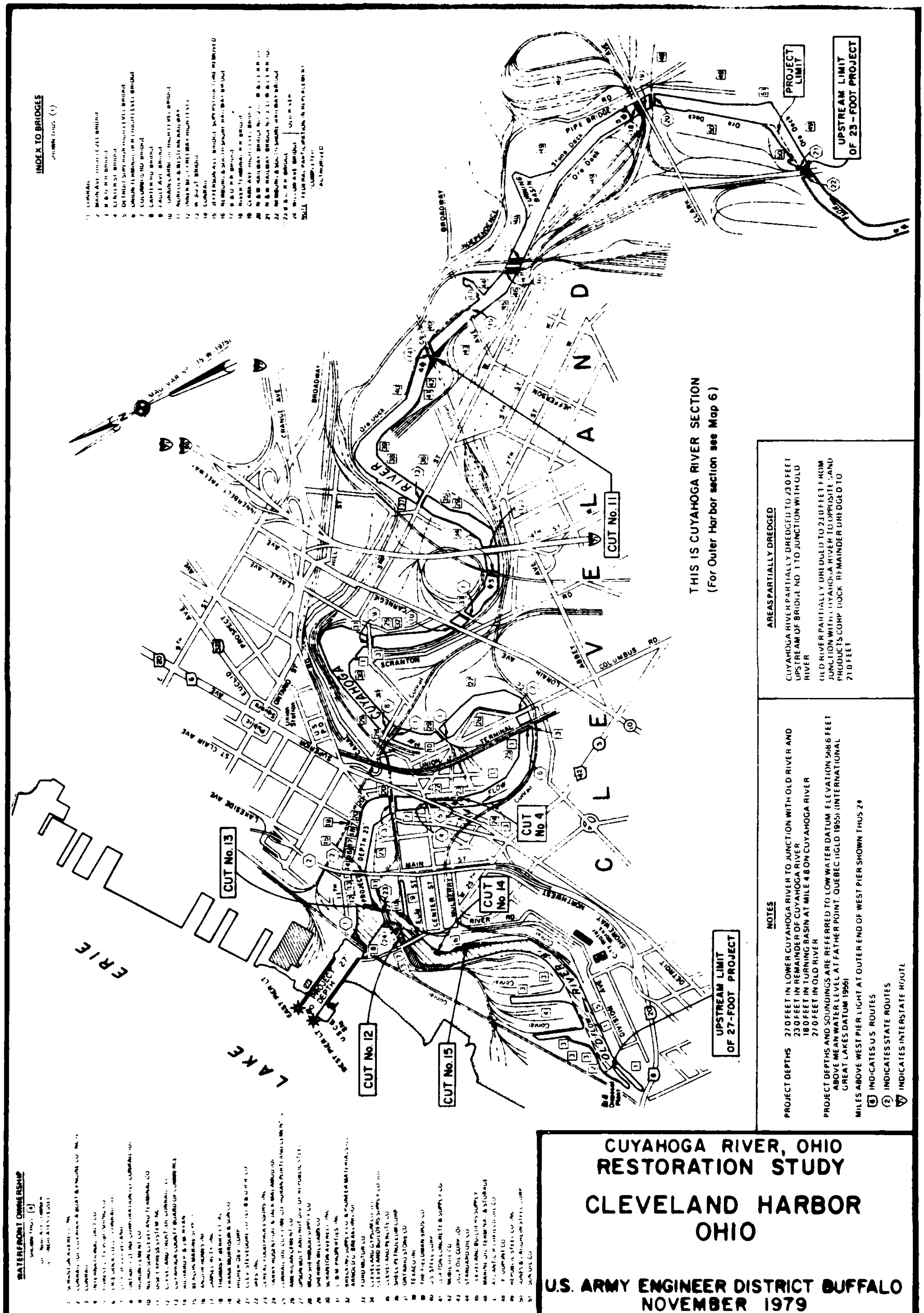
c. Dredging of Cleveland Harbor - The harbor at Cleveland, Ohio consists of a breakwater protected lakefront harbor in Lake Erie and improved navigation channels on the Cuyahoga River and Old River. The harbor is Federally improved and is shown on Figures 8 and 9. When sediment carried by the Cuyahoga River reaches the relatively quiet waters of the navigation channel and lakefront harbor, it deposits and forms shoals. These shoals must then be removed by maintenance dredging costing approximately $4,000,000 per year.

The Corps of Engineers is responsible for dredging Cleveland Harbor to authorized depths. The dredging operations have historically been divided into contract dredging on the river channels and the Government's hopper dredging in the lakefront harbor.

Contracts with private firms for maintenance dredging of the river channels provide for starting the work in the fall of one year and completing it in the spring of the following year. Under the contracts, the upper mile of the Cuyahoga River navigation channel is dredged in the late fall to three feet below project depth. This is the area where most of the sediment load from the upper river is deposited. The extra depth provides room for storage of most of this load over the winter and concentrates it for ease of dredging in the spring. Without this extra depth, sediment transported by the spring runoff could significantly shoal the navigation channel and restrict commercial shipping until the spring dredging is completed, generally some time in July.

The three Buffalo District hopper dredges begin the lakefront harbor maintenance dredging at Cleveland in early spring, as soon as ice conditions permit. As warmer weather reduces the ice on Lake Erie, the hopper dredges are dispatched to other harbors. The outer harbor maintenance is completed before the last dredge departs Cleveland, generally some time in April.


LAKE ERIE
DISPOSAL AREA
SCALE OF FEET
INSET B
U.S. RESERVATION AND STOREHOUSE
SCALE OF FEET
INSET A
WEST BASIN
EAST BASIN
PROJECT DEPTH 27.0 FEET
PROJECT DEPTH 29.0 FEET
EAST BREAKWATER
CLEVELAND
THIS IS OUTER HARBOR SECTION
NOTES
INDICATES U.S. ROUTE
INDICATES STATE ROUTE
INDICATES INTERSTATE ROUTE
INDICATES CITY OF CLEVELAND DOCK NUMBERING SYSTEM
WATERFRONT OWNERSHIP
1. CONRAIL
2. GREAT LAKES DREDGE AND DOCK CO. (L) CONRAIL (O)
3. CITY OF CLEVELAND (O)
4. NICHOLSON CLEVELAND TERMINAL CO. (O)
5. EAST 55th ST. MARINA, CITY OF CLEVELAND (O)
6. CLEVELAND ELECTRIC ILLUMINATING CO. (O)
CUYAHOGA RIVER, OHIO
RESTORATION STUDY
CLEVELAND HARBOR
U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979
FIGURE 8



CUYAHOGA RIVER, OHIO
RESTORATION STUDY

CLEVELAND HARBOR OHIO

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979

FIGURE 9

The volume of material annually dredged from the navigation channels through contracts with private dredging firms and the lakefront harbor dredging by the Government's hopper dredges is recorded and published in the annual report of the Chief of Engineers. A summary of the data for the 10-year period, 1968 to 1977, is presented in Table 10. The data shows that 800,000 cubic yards is annually dredged from the lakefront harbor and navigation channels. As previously mentioned, this maintenance work costs approximately $4,000,000 annually.

In addition to the volume of material annually dredged at Cleveland Harbor by the Corps of Engineers, a small amount of permit dredging is accomplished by private dock owners. A summary of the data for the nine-year period, 1969 to 1977, is presented in Table 11. The data shows that 60,000 cubic yards is annually dredged by private dock owners.

The sediment that is dredged from Cleveland Harbor is classified as heavily polluted based on present U.S. Environmental Protection Agency standards and requires confined dike disposal in lieu of traditional open-lake dumping. Therefore, in addition to the $4,000,000 cost for dredging operations at Cleveland Harbor, an additional cost is incurred for providing diked disposal areas.

d. Navigation Interests - In addition to the annual cost for dredging the navigation channels and lakefront harbor, sediment accumulation poses severe problems to commercial shipping interests utilizing the harbor facilities. Since the spring dredging operation on the navigation channel is normally not completed until July, vessels must lighter (reduce load) in the lakefront harbor before proceeding upriver. This extra handling produces an increased charge for delivery of the cargo. Vessels must also maneuver around the dredging equipment during dredging operations and are thus both inconvenienced and exposed to additional hazards. Sediment also enters the ship's ballast system as empty vessels take on sediment-laden ballast water for purposes of handling the ship when departing the harbor. The sediment settles out and accumulates until the ship is laid-up and the sediment is physically removed. In addition to the cost for removing this sediment, the capacity of the vessel is also reduced by the amount of sediment carried by the ship. Recent correspondence with shipping interests outlining these problems and requesting that the Corps of Engineers investigate sediment control in the Cuyahoga Valley are presented as Exhibits G-1, G-2, and G-3 in Appendix G, "Pertinent Correspondence."

e. Restoration of Lake Erie - As previously stated, the Lake Erie Wastewater Management Study, presently being conducted by the Buffalo District, has identified nutrient enrichment - particularly phosphorus in all of its forms - as the primary cause of eutrophication of Lake Erie. Phosphates attach themselves to soil particles and when these soil particles

Table 10 - Volume of Material Annually Dredged from the Navigation Channel and Lakefront Harbor at Cleveland, Ohio[1/]

Fiscal Year	Volume Dredged from Lakefront Harbor (cy)	Volume Dredged from Navigation Channel (cy)	Total (cy)
1968	428,000	548,000	976,000
1969	233,000	477,000	710,000
1970	104,000	926,000	1,030,000
1971	178,000	557,000	735,000
1972	194,000	554,000	748,000
1973 2/	-	308,000	308,000
1974 2/	88,000	270,000 3/	358,000
1975 2/	-	597,000	597,000
1976	73,000	706,000	779,000
1977	158,000	598,000	756,000
Average 4/			819,000 Say 800,000

1/ From the annual reports of the Chief of Engineers on Civil Works Activities.

2/ Dredging was not done to authorized depth due to insufficient capacity of the diked disposal area.

3/ Includes 187,000 cy dredged by Corps hopper dredge.

4/ The years 1973, 1974, and 1975 were excluded from the average due to reduced dredging.

Table 11 - Volume of Material Annually Dredged by Private Dock Owners

Year	Quantity Dredged (cy)
1969	61,000
1970	50,000
1971	36,000
1972	31,000
1973	55,000
1974	69,000
1975	40,000
1976	83,000
1977	97,000
Average	58,000 Say 60,000

are eroded and transported by the river to Lake Erie, they act as a carrier for the attached phosphates.

The Great Lakes Water Quality Agreement of 1978 calls for, among other things, a 30 percent reduction in phosphorus introduced into Lake Erie from diffuse sources (erosion of the land surface). In order to meet this goal, areas where significant sheet erosion is occurring must be identified in order that an effective erosion control plan can be formulated and implemented.

10. PLANNING CONSTRAINTS

During this Stage 2 planning effort, several planning constraints were identified which impacted on the conduct of the study and the formulation of alternative plans developed to control erosion in the study area. These planning constraints include the following: (1) environmental; (2) National Park Service policies for the Cuyahoga Valley National Recreation Area; (3) Corps of Engineers Policy; (4) state-of-the-art techniques in predicting sheet erosion (erosion of the surface of the land); and (5) the physical size of the study area. These constraints are reviewed below.

a. Environmental Constraints - All plans of improvement should avoid or minimize objectionable or adverse impacts to aquatic or terrestrial habitat and maximize environmental benefits prior to, during, and following construction. A plan should avoid or minimize water pollution and aesthetically objectionable features. Adherence to this principle will result in speedy public and agency acceptance of the recommended plan of improvement.

The U.S. Fish and Wildlife Service (USF&WL Service), in their "Planning Aid Letter" dated 6 December 1978 (Exhibit E-3), stated that they favor the establishment of vegetative ground cover for control of eroding upland areas provided that a variety of vegetation types are utilized. They also favor the establishment of vegetation to control eroding streambanks. Their second preference for streambank stabilization is the use of stone riprap. They are opposed, however, to the extensive use of riprap or streambed alteration because the potential adverse impacts to the fish and wildlife resources of the area are so great.

Throughout the conduct of this Stage 2 planning effort, vegetation was the preferred treatment method in controlling erosion. As will be discussed in Section C of the Main Report, where vegetation was well established and undisturbed by man, no erosion was taking place. It therefore appears that vegetation is nature's way of controlling erosion. Economics also dictated that vegetation be utilized as much as possible since its cost was less than other types of land treatment (terracing, grade control structures, subsurface drainage, etc.) and streambank stabilization techniques (riprap, gabions, etc.). Where the erosion forces were too great to be controlled by vegetation, such as at sharp bends in the river and on long, steep slopes, other types of structural measures were specified. These structural measures were kept to a minimum not only to preserve the existing environment, but to reduce the cost of the alternatives that were formulated.

If the recommendation of this Preliminary Feasibility Report is to continue into Stage 3 planning, the effectiveness of the alternative(s) selected for further study in preserving the existing environment will be assessed in the Environmental Impact Statement. The biological data required to prepare this EIS will be collected during the early part of Stage 3 planning since the USF&WL Service has stated that existing data cannot be used to evaluate alterations of habitat conditions at specific sites. This existing data was utilized, however, for a preliminary assessment of the effects of the alternatives formulated to control erosion on the existing environment for this Preliminary Feasibility Report.

b. National Park Service Policies for the Cuyahoga Valley National Recreation Area - A majority of the study area (the 303 square-miles of the Cuyahoga River Basin between Independence and Old Portage) lies within the boundaries of the Cuyahoga Valley National Recreation Area administered by the National Park Service. In their "General Management Plan," July 1977, the National Park Service lists several policies which will guide management of the park's natural resources. Several of the policies stated in the plan and which impacted on the course of this study are as follows:

(1) Although Cuyahoga has been designated as a national recreation area, some of its lands will be administered to reflect the more stringent natural resources management policies for national parks.

(2) All specimen trees, groves, forests, remnant stands, and other significant plant communities will be preserved for scientific and interpretive purposes.

(3) The introduction of exotic plants not already present in the park in significant numbers will be discouraged on Federal lands. Exempted communities will be encouraged to preserve stands of native vegetation wherever they occur.

(4) Landscapes damaged by man-made alterations (e.g., road cuts) will be repaired - to the extent feasible and acceptable - and then natural processes will be allowed to take over in restoring and maintaining these conditions.

(5) Environmentally compatible methods will be employed to restrain and retard the inevitable erosional and depositional transformation of the valley due to ever-increasing stormwater runoff and periodic flooding. Wherever possible, natural processes will be allowed to continue uninterrupted.

(6) The restoration or repair of riverbanks in the valley for the purposes of erosion and sedimentation control will be undertaken only where consulting experts indicate that such actions are necessary to offset past damage caused by human activities or that excessive erosion, siltation, and sedimentation may impair the achievement of water quality standards.

(7) No new dams or diversions will be constructed or channelization undertaken within the park boundary.

(8) During construction of any facilities or systems required to properly manage and protect the park, the National Park Service will employ technology that has the least effect on surrounding ecosystems. Planning and design of such structures will take into consideration energy requirements and will stress energy conservation and economy of construction.

Throughout the course of this study, informal discussions were held with National Park Service personnel to insure that the alternatives formulated to control erosion were compatible with the stated policies of that agency. In addition, as discussed in the following sections of the Main Report, these policies formed the basis for eliminating various alternatives from further consideration.

c. Corps of Engineers Policy - The purposes of this study are to determine the prolific sources of sediment throughout the study area (from land and streambank erosion) and identify methods of controlling erosion and sedimentation through structural and/or nonstructural means. Implementation (construction) of plans to control streambank erosion will be pursued by the Corps of Engineers under the existing study authority as this authority provides for implementation as well as investigation. Implementation of measures to control erosion in the upland area (the 303 square-mile drainage basin), must, however, be pursued by other interests. Corps of Engineers policy prohibits active participation in improvements on privately-owned land (in this instance, the Cuyahoga Valley National Recreation Area is classified as privately-owned land). The Corps can, however, offer encouragement to local interests who desire to implement land management programs to control erosion. In addition, a series of general management programs will be developed in this report to inform local interests as to the types of treatment measures that would be required to control erosion in the upland area and the magnitude of costs involved. The Corps also proposes to disseminate the results of this study and to encourage local interests to implement erosion control practices.

d. State-of-the-Art Techniques in Predicting Erosion - As discussed in Section C of the Main Report, the Universal Soil Loss Equation (USLE) was used by the Soil Conservation Service to predict sheet erosion that is occurring on the surface of the land within the study area. The USLE is an empirical formula, developed at the Agricultural Research Service - U.S. Department of Agriculture, that groups the numerous interrelated physical and management parameters that influence the rate of erosion into six major factors that can be expressed numerically. Selection of specific numerical values for these six factors are determined at the particular site under study. Although research has supplied information from which at least approximate values may be obtained, selection of these values relies on a subjective evaluation of the physical conditions of the site under study by field personnel. There are also numerous reservations regarding the use of this equation for large basin studies since the formula was initially developed to predict soil loss from specific farm fields and other small land areas. In addition, while the USLE estimates the quantity of soil loss from the area under study, it does not predict the delivery of this soil to the receiving stream. In spite of these limitations and the possibility of erroneous results, the equation is recognized as the most reliable method of quantifying potential soil movement that is currently available.

e. Physical Size of the Study Area - Because of the physical size of the area under study (303 square-miles), it was not economically feasible to evaluate each individual site in the study area in order to estimate sediment production from sheet erosion. Therefore, as discussed in Section C of the Main Report, the USLE was applied to a representative sample of the area, and the results were expanded based on the established sampling rate. Although errors are inherent in any sampling procedure of this type, it was not felt that it would adversely affect the results of the study, particularly since techniques for predicting sheet erosion (USLE) are not exact.

11. NATIONAL OBJECTIVES

Current Federal policy, as developed by the President's Water Resources Council, requires that the alternative water and related resource plans be formulated in accordance with the national objectives of National Economic Development (NED) and Environmental Quality (EQ). Therefore, in accordance with the guidance established in Engineering Regulation 1105-2-200, "Multiobjective Planning Framework," dated 10 November 1975, this study will be consistent with the planning requirements of the Water Resources Council "Principles and Standards" (P&S) and related policies. In accomplishing the study, equal consideration will be given to the P&S objectives of NED and EQ described below:

National Economic Development (NED) - National Economic Development is achieved by increasing the value of the nation's output of goods and services and improving economic efficiency.

Environmental Quality (EQ) - Environmental Quality is achieved by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

12. SPECIFIC PLANNING OBJECTIVES

Specific planning objectives are the National, State, and local water and related land resources management needs (opportunities and problems) specific to a study area that can be addressed to enhance National Economic Development and Environmental Quality. Based on a review of the directives established by the authorizing resolutions, previous reports for the area, statements by individuals in the private sector, input from officials at many levels of government, and an analysis of the problems and needs of the study area, as discussed previously, the specific planning objectives for the Cuyahoga River Restoration Study - "Third Interim Report on Erosion and Sedimentation" that have been identified are as follows:

a. Local interests have expressed a need for identifying and quantifying sources of erosion in the Cuyahoga River Basin. Identification of sources of erosion is also required before effective erosion control practices can be formulated and constructed. Therefore, the first objective of this study is to identify and quantify the significant sources of erosion in the 303 square-mile watershed between Independence (river mile 13.8) and Old Portage (river mile 40.25). This reach of the Cuyahoga River Basin was previously identified as the most prolific source of sediment in the river system.

b. Erosion and sedimentation is a serious problem in the Cuyahoga River Basin. The Corps of Engineers annually spends approximately $4,000,000 in dredging the navigation channels and lakefront harbor at Cleveland, Ohio. In addition, because the sediment dredged is heavily polluted, it requires expensive diked disposal in lieu of traditional open-lake dumping. The Lake Erie Wastewater Management Study has identified phosphorus, which is transported in part by eroding soil particles to Lake Erie, as the major cause of degradation of Lake Erie. Navigation interests have also stated that sediment accumulation in Cleveland Harbor interferes with their use of the harbor facilities and increases the delivery cost of the cargo shipped. Therefore, one objective of this study will be to formulate and implement a plan to control streambank erosion and to develop a general management program that informs local interests of the types of measures that would be required to control sheet erosion in the upland area and the magnitude of the costs involved.

c. Any development that adversely impacts on the existing fish and wildlife habitat in the study area poses severe environmental concerns. Therefore, one objective of this study will be to minimize or eliminate any adverse environmental impacts resulting from this project on the existing fish and wildlife habitat. This objective could be met, for example, by employing nonstructural means (vegetation) wherever feasible.

13. CONDITIONS IF NO FEDERAL ACTION TAKEN

In any formulation, there is always the basic question of "is there a justified need for change?" Therefore, the conditions that would exist if no Federal action were taken to control streambank erosion were investigated for this Preliminary Feasibility Report. (As previously stated, although general management programs to control sheet erosion in the upland area will be developed in this report, Corps of Engineers policy prohibits active participation in implementing these plans.) Rather, the Corps will look to local interests to implement these plans. Besides answering the basic question, these conditions will also provide a common basis for comparing alternative plans of improvement as discussed in Section C of the Main Report.

As a result of no action, streambank erosion will continue to adversely impact on residents of the Cuyahoga River Basin, the Federal Government, and users of Cleveland Harbor. Sediment introduced into the river from streambank erosion will continue to settle out and form shoals in the navigation channel and lakefront harbor at Cleveland. These shoals will have to be removed by expensive maintenance dredging costing approximately $4,000,000 per year. In addition, since the sediment dredged from Cleveland Harbor is classified as heavily polluted, it will require diked disposal. Navigation interests will also be inconvenienced when using the harbor facilities as they maneuver around the dredging equipment and are forced to lighter due to reduced channel depth before dredging operations are completed.

If no Federal action were taken, the existing environment would not be disturbed. However, since sediment carried by the river adversely affects aquatic life, this would not be a completely desirable situation. No action would also aid in meeting the stated policies of the National Park Service in that no construction would occur within park lands to control streambank erosion. Visitors to the park, however, would not realize the full value of their experience since the river would present an aesthetically unpleasing appearance.

SECTION C
FORMULATION OF ALTERNATIVE PLANS

The purpose of this section is to inform the reader of this report of the alternative plans that were developed to control erosion and sedimentation. The section begins with a discussion on the results of the studies conducted to identify and quantify the sources of sediment in the study area. The remainder of the section is subdivided into two main topics of discussion: (1) alternatives formulated to control streambank erosion; and (2) management programs formulated to control erosion in the upland area (the 303 square-mile drainage basin of the Cuyahoga River between Independence (river mile 13.8) and Old Portage (river mile 40.25)). Each discussion will review the general measures that are available to control erosion and sedimentation; the formulation and evaluation criteria used in this Stage 2 evaluation; and the development of plans of improvement to control erosion and sedimentation.

14. RESULTS OF EROSION AND SEDIMENTATION STUDY

Previous studies in the recent past have indicated the major erosion and sedimentation problem areas in the Cuyahoga River Basin occur between Independence (river mile 13.8) and Old Portage (river mile 40.25) (see Figure 2). Dr. Robert Apmann, for example, in his report on "Erosion and Sedimentation of the Cuyahoga River Basin, 1973" identified this section of the Cuyahoga River Basin as the most prolific source of sediment in the river system. These findings were confirmed by a United States Geological Survey (USGS) one-year suspended sediment gaging program in the Cuyahoga River Basin. The results of this program indicated that approximately 20,000 tons of suspended sediment passed through the gage at Old Portage (404 square-mile drainage area) and approximately 235,000 tons passed through the gage at Independence (an additional 303 square-mile drainage area or 707 square-miles total). Thus 215,000 tons of suspended sediment was added to the river system in this 303 square-mile drainage area. The USGS data also indicated that of the six major tributaries of the Cuyahoga River between Independence and Old Portage, Tinkers Creek and Brandywine Creek contributed the heaviest suspended sediment loads (29,000 tons per year and 10,000 tons per year, respectively). Copies of Dr. Apmann's report and the USGS report on their "Suspended Sediment Sampling Program" are included in Appendix E as Exhibits E-1 and E-2, respectively.

In January 1977 the Buffalo District entered into an Interagency Support Agreement with the U. S. Soil Conservation Service (SCS) to identify and quantify the sources of sediment in this reach of the Cuyahoga River Basin. In their investigation, the SCS divided the study into two components or individual study areas: the channel component and the upland watershed component. The channel component consists of the main stem (main channel) of the Cuyahoga River and the channels of the six major tributaries which enter the river within the study area. The channel component will identify and estimate the quantity of sediment derived from erosi ·f the channel banks. The upland watershed component consists of the 303 · are-mile watershed area between Old Portage and Independence. The upland watershed component will identify sediment sources and estimate the sediment delivered to the Cuyahoga River from erosion of the land surface.

The results of the studies conducted for each component are summarized below. Details of these studies, including detailed descriptions of the methodologies used to identify and quantify the sources of sediment for each component and the results of the studies conducted, are presented in Appendix A - "Identification of Sources of Erosion." The reader is encouraged to review this appendix in order to gain a full understanding of the erosion and sedimentation problems that exist in the basin.

a. Channel Component

(1) General - The channel component consists of the main stem of the Cuyahoga River from Independence (river mile 13.8) to Old Portage (river mile 40.25) and the channels of the six major tributaries in this reach (see Figure 10 and Plates A2-1 to A2-5 in Appendix I). These tributaries are Mud Brook, Brandywine Creek (including Indian Creek, the major tributary of Brandywine Creek), and Tinkers Creek on the east side of the basin and Yellow Creek, Furnace Run, and Chippewa Creek on the west side of the basin. Two of these tributaries, Brandywine Creek and Tinkers Creek, were studied for their entire length. The reason for this was that the USGS gage data indicated that these two tributaries contributed the heaviest suspended sediment load of the six tributaries studied. The remaining four tributaries were only studied from their confluence with the Cuyahoga River upstream to the USGS gaging station on each tributary. If the recommendation of this report is to continue into Stage 3 planning, additional studies will be conducted on Furnace Run and Mud Brook because extensive areas of streambank erosion were observed while collecting the field data required for the upland component study area. The remaining two tributaries will not be studied due to field observations that indicated channel erosion was not a significant problem in these tributaries.

Sediment produced from streambank erosion was classified as either annual streambank erosion or meander changes. Annual streambank erosion is the average amount of soil loss from the banks of a stream in one year. Meander changes are areas where the stream changes its course during a major runoff event. The methods used to estimate streambank erosion and the results of the studies conducted for each category are discussed below.

(2) Annual Streambank Erosion - A streambank field data survey was conducted by the SCS from September 1977 to September 1978 to locate areas of annual streambank erosion. For this survey, the streams were divided into short reaches of similar characteristics (typically, the length of the reach ranged from 200 to 1,000 feet) and data was recorded for each reach. Data recorded included, among other things, the adjacent land use (pasture, cropland, forest, urban or other (cut and fill areas, roads and small farmsteads)), adjoining soil type (obtained from soil surveys made by the SCS and the Ohio Department of Natural Resources, Division of Lands and Soil) the average bank height of the reach, the length of the reach, and whether or not the streambank was eroding. Where a streambank was eroding, the average rate of annual lateral recession (the lateral distance an eroding streambank recedes in 1 year) was also recorded. This rate was determined based on, among other things, visual observation of the eroding streambank and surrounding area and interpretation of aerial photos between 1938 and 1977. Once the above data was collected for the entire channel component study area, the volume of annual streambank erosion was calculated.

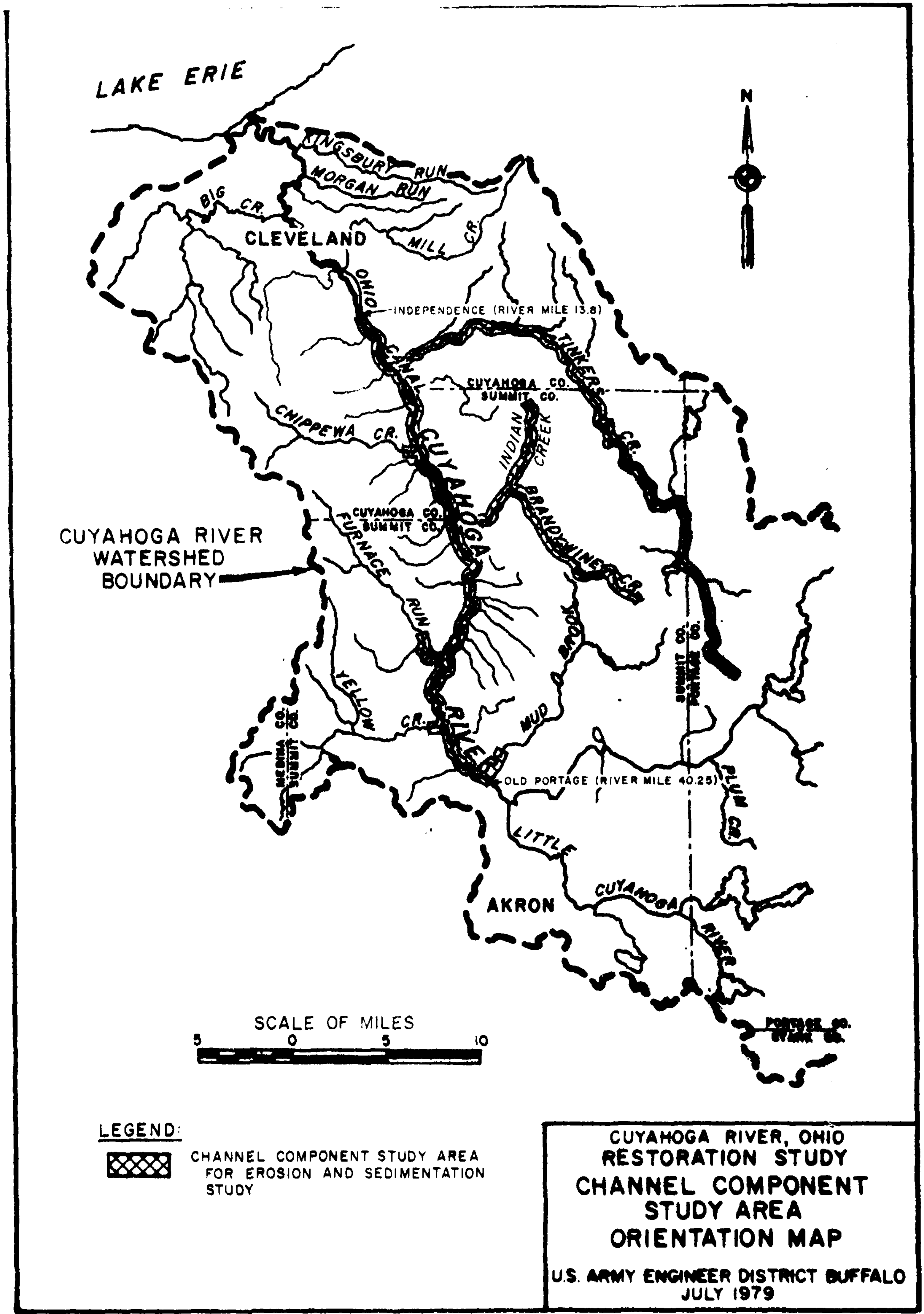

LAKE ERIE
KINGSBURY RUN
MORGAN RUN
BIG CR.
MILL CR.
CLEVELAND
OHIO CANAL
INDEPENDENCE (RIVER MILE 13.8)
TINKERS CR.
CUYAHOGA CO.
SUMMIT CO.
INDIAN CREEK
CHIPPEWA CR.
CUYAHOGA
BRANDYWINE CR.
CUYAHOGA RIVER
WATERSHED
BOUNDARY
FURNACE RUN
BROOK
MUD
YELLOW CR.
RIVER
MEDINA CO.
SUMMIT CO.
SUMMIT CO.
PORTAGE CO.
OLD PORTAGE (RIVER MILE 40.25)
PLUM CR.
LITTLE
CUYAHOGA RIVER
AKRON
PORTAGE CO.
STARK CO.
N
SCALE OF MILES
5 0 5 10
LEGEND:
CHANNEL COMPONENT STUDY AREA FOR EROSION AND SEDIMENTATION STUDY
CUYAHOGA RIVER, OHIO
RESTORATION STUDY
CHANNEL COMPONENT
STUDY AREA
ORIENTATION MAP
U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1979

FIGURE 10

The results of the streambank data survey indicated that of the 143 miles of streambanks in the study area (this includes both banks so that in one stream mile there are two streambank miles) only 22.7 miles, or 16 percent, were actively eroding. The location of these eroding streambanks are shown on Plates A2-8 to A2-12 in Appendix I. Each area of streambank erosion is identified by two sets of numbers. The first set of numbers refers to the river mile where the eroding streambank is located. The second set of numbers refers to the particular reach within that river mile. For example, 21-6 refers to river mile 21 and Reach 6.

Table 12 presents a summary of the estimated volume of sediment produced from annual streambank erosion. As indicated, annual streambank erosion produces about 52,000 cubic yards of sediment (or 78,000 tons) per year. The Cuyahoga River (between river mile 13.8 and 40.25) contributes the largest amount of sediment (approximately 24,000 cubic yards per year or 46 percent of the total volume) followed by Tinkers Creek (18,000 cubic yards per year or 35 percent of the total volume). Chippewa Creek and Mud Brook produce the least amount of sediment (7 cubic yards per year and 337 cubic yards per year, respectively) and are insignificant.

Several areas of the streams studied produce the majority of the sediment derived from annual streambank erosion. These areas are as follows:

(1) Cuyahoga River:	river mile 13.8 to 15.1
	river mile 18.0 to 20.0
	river mile 22.0 to 25.0
	river mile 26.0 to 27.0
	river mile 30.0 to 33.0
(2) Furnace Run:	stream mile 0.0 to 1.5
(3) Yellow Creek:	stream mile 0.0 to 0.8
(4) Brandywine Creek:	stream mile 1.0 to 2.0
(5) Tinkers Creek	stream mile 1.0 to 2.0
	stream mile 11.0 to 12.0

These areas produce 44,000 cubic yards of sediment per year or 85 percent of the total volume from annual streambank erosion.

Two reaches, reach 1-7 in Brandywine Creek and reach 1-6 in Tinkers Creek, were identified as the highest producers of sediment from annual streambank erosion in the study area. High rates of annual lateral recession (3.5 feet per year and 10 feet per year, respectively) in conjunction with bank heights in excess of 70 feet produce 16,000 cubic yards of sediment per year, or 30 percent of the total volume for the entire study area. The majority of the other eroding reaches in the study area had bank heights that averaged about 8 feet and annual lateral recession rates between 0.1 to 1.5 feet per year.

Table 12 - Estimated Volume of Annual Streambank Erosion - Total Channel Component Study Area

Channel Component	Total Annual Streambank Erosion (cy/yr)
Cuyahoga River (river mile 13.8 to river mile 40.25)	23,712
Chippewa Creek (stream mile 0.0 to stream mile 0.4)	7
Furnace Run (stream mile 0.0 to stream mile 1.5)	2,106
Yellow Creek (stream mile 0.0 to stream mile 0.8)	2,907
Mud Brook (stream mile 0.0 to stream mile 0.2)	337
Brandywine Creek (stream mile 0.0 to stream mile 11.6 and Indian Creek)	5,092
Tinkers Creek (stream mile 0.0 to stream mile 27.3)	18,094
Total	52,255 say 52,000 (or 78,000 tons/yr 1/)

1/ Assumed unit weight of 110 lbs. per cubic foot.

Trash (dead trees, construction debris, etc.) and bedload bar buildup is a contributing factor to the high rates of annual lateral recession at several locations (river mile 19.6, 26.2, 31.5, and 32.5 on the Cuyahoga River, stream mile 0.4, 0.6, 0.7, and 0.9 on Furnace Run and stream mile 0.3 and 0.6 on Yellow Creek). Trash buildup gouges the bank as it becomes lodged and deflects the stream flow either into the toe of the bank, causing undercutting, or into the river bed, causing scouring. Bedload bar buildup reduces the channel cross-section, causing an increase in flow velocity and a corresponding increase in the erosion force of the stream. Since the alluvium soils of the streambanks offer less resistance to erosion than the bedload bars, this increased erosion force acts against the streambanks resulting in higher rates of annual lateral recession.

There are also several locations along the Cuyahoga River where topsoil stripping operations have lowered the existing streambank (river mile 15.5, 16.2, 24.4, 25.2, 25.3, and 25.7 on the west bank and river mile 24.3 on the east bank). This allows the river to leave its banks during periods of above-average flow and scour its flood plain. Although the quantity of sediment eroded from the flood plain during periods of overbank flow was not quantified for this report, it is believed to be significant in these areas because the topsoil stripping operation removes the protective vegetative covering.

There are several sites within the study area where damage to local roads and railroad facilities of the Baltimore and Ohio Railroad will occur in the near future because of the high rates of annual lateral recession at these locations. Local roads that are endangered occur at river mile 24.6 and 35.0 on the Cuyahoga River. Damage to these roads can be expected within 20 and 15 years, respectively. Damage to railroad facilities at river mile 14.8 and 26.2 on the Cuyahoga River, stream mile 0.4 on Furnace Run and stream mile 0.2 on Yellow Creek can be expected to occur within 10 years, 10 years, 5 years, and 5 years, respectively. Damage to these railroad facilities will adversely impact on the industries located in Cleveland since the B&O Railroad system is one of the major trunk lines serving Cleveland.

A correlation can be made between adjacent land use and streambank erosion. Streambanks adjacent to land uses that disturb or destroy the protective vegetation covering (cropland and other land (cut and fill areas, roads, and small farmsteads)) are more susceptible to erosion than streambanks adjacent to forest land. The forest vegetation acts as a buffer, absorbing part of the erosion force of the stream before it comes in contact with the soil surface. There are, however, streambanks that are forested that are also eroding. They generally occur on the outside of sharp bends in the stream where the erosive forces of the streams are greater. These forces generally cause streambank erosion no matter what type of vegetation is present.

No correlation could be made between streambank erosion and soil type. The majority of the soils encountered were alluvium soils primarily composed of silts and fine sands and have similar texture characteristics. Because of the similar texture characteristics, no individual soil type appeared to be more susceptible to erosion than another.

As previously indicated, annual streambank erosion produces about 52,000 cubic yards of sediment annually. A portion of this sediment, however, settles out before it reaches Cleveland Harbor. This sediment either forms bedload bars, which usually contribute to the high rates of annual lateral recession, or is deposited on the inside of bends in the streams. Sieve analyses for the soil types encountered in the study area, as reported in the Soil Survey Reports prepared by the Soil Conservation Service and the Ohio Department of Natural Resources, Division of Lands and Soil, indicated that the soils encountered had a proportion of particles with a diameter of one-quarter inch or larger of about 10 percent. It is assumed that these particles are too heavy to be transported by the Cuyahoga River to Cleveland Harbor and thus settle out. Therefore, it is estimated that about 10 percent of the sediment produced from annual streambank erosion, or 5,000 cubic yards, settles out before it reaches Cleveland Harbor. This assumption appears reasonable since no major areas of deposition were located while conducting the streambank data survey.

As discussed in Section B - "Problem Identification" of the Main Report, the Corps of Engineers annually dredges about 800,000 cubic yards of sediment from the navigation channel and lakefront harbor at Cleveland. In addition, private dock owners annually dredge an additional 60,000 cubic yards of sediment. Therefore, the total volume of sediment annually dredged is 860,000 cubic yards. By comparing the volume of sediment produced from annual streambank erosion which reaches Cleveland Harbor (52,000 cubic yards - 5,000 cubic yards, or 47,000 cubic yards) with the 860,000 cubic yards of sediment dredged, it can be concluded that annual streambank erosion accounts for only about 5 percent of the sediment dredged and is insignificant. Therefore, other sources of sediment must be identified if an effective sediment control program is to be implemented that would significantly reduce dredging at Cleveland Harbor.

(3) Meander Changes - As previously defined, meander changes are areas where the stream changes its course during a major runoff event. This course change is caused by erosion of the alluvium flood plain soils and typically occurs at large bends in the river (meander loops). When the river is confined to a narrow flood plain due to geologic features, meander changes do not occur.

In order to predict where future meander changes would occur, previous meander changes were identified and studied to gain an understanding of the phenomenon. The first step was to develop Plates A2-6 and A2-7 in Appendix I (Changes in River Channel) which depict the approximate location of the river channel in the years 1938, 1963, 1967, and 1977 based on aerial photos for 1938 and 1977 and the USGS topographic maps published in 1963 and 1967. These plates were evaluated and major meander changes were identified at river mile 14.7, 17.9, 23.0, 24.8, 31.1, 32.9, and 39.3. It is estimated that these meander changes produced approximately 110,000 cubic yards of sediment when they formed.

The meander changes that occurred at river miles 31.1 and 32.9 formed new meander loops. Physical evidence (deposition areas) indicated that these meander loops formed as a result of the sediment load from Furnace Run. When the sediment-laden flow from Furnace Run entered the Cuyahoga River, its velocity was reduced. This reduced flow velocity allowed the heavier sediment (gravel and coarse sand) to settle and form bedload bars. These bedload bars in turn blocked the original river course and forced the river to form a new channel.

The remaining existing meander changes formed when the Cuyahoga River cut a new channel through the neck of an existing meander loop. In meander loops, the erosive force of the river is directed against the outside banks of the curve resulting in high bank erosion rates. As a result of these high erosion rates, the width of the meander neck narrows during succeeding years. When the width is sufficiently narrow, the river breaches the meander neck and forms a new channel across it. It is not known why the original meander loops formed although it is probable that they formed as a result of sediment bar formation in the original river channel.

The information gathered from investigating previous meander changes was used to locate potential sites of new meander changes while conducting the streambank survey. All meander loops encountered while conducting the streambank survey were evaluated to see if there was any evidence that the river was attempting to cut a new channel across the meander neck. Six potential sites were identified (river mile 23.3, 25.3, 25.7, 26.1, 34.8, and 39.0), and their potential new courses are illustrated on Figures A2.4 to A2.7 in Appendix A. (Two different meander changes will occur at river mile 34.8. Meander change (a) will occur first and then meander change (b) will form later.) In all cases, man has disturbed the protective bank vegetative cover which has: (1) increased the rate of bank erosion against the meander neck as identified by the high estimated rates of annual lateral recession at these locations; and (2) created a path of reduced resistance for overland flow across the meander neck. At all six sites, flood plain scour in a confined area across the meander neck was present. The potential course of the river was further defined by debris buildup along either side of the scoured area. This evidence led to the conclusion that the river was cutting a new channel. In addition, at several sites (river miles 23.3, 26.1, and 39.0) the new channel paralleled the river channel in 1938 and is located on the opposite side of the 1938 channel in relation to the present (1977) channel. This indicates that meander changes on the Cuyahoga River tend to form within a defined meander belt.

Table 13 presents the calculations that were performed to estimate the quantity of sediment that will be introduced when the meander changes occur. As indicated, 125,000 cubic yards of sediment will be produced. This volume is equivalent to the volume of sediment produced from approximately two and one-half years of annual streambank erosion.

Table 13 - Potential Meander Changes - Cuyahoga River
(river mile 13.8 to 40.25)

Location by River Mile	Estimated New Channel Dimensions Length (feet)	Width (feet)	Depth (feet)	Quantity of Sediment that Would be Produced (cubic yards)
23.3	500	70	7	9,074
25.3	800	70	6	12,444
25.7	900	70	6	14,000
26.1	500	70	5	6,481
34.8(a)	900	80	8	21,333
34.8(b)	1,400	80	8	33,185
39.0	900	100	8	26,667
Total				123,184 say 125,000

b. Upland Watershed Component

(1) General - The upland watershed component is concerned with gross erosion (dislodgement or detachment of soil particles) of the land surface and delivery of this sediment to a stream channel in the 303 square-mile drainage basin of the Cuyahoga River between Independence (river mile 13.8) and Old Portage (river mile 40.25) (see Figure 2). For the purpose of this report the sources of sediment have been divided into two areas: (1) sediment produced from diffuse nonpoint sources of erosion; and (2) sediment produced from identifiable nonpoint sources of erosion. Diffuse nonpoint sources of erosion refer to the entire land surface where sheet and rill erosion occurs. Identifiable nonpoint sources of erosion refer to those areas where highly visible gully erosion on disturbed areas is taking place. The methods used to estimate gross erosion and the results of the studies conducted for each source type are discussed below.

(2) Diffuse Nonpoint Sources of Erosion - The 303 square-mile study area was divided into seven subwatersheds for the sheet or diffuse nonpoint source erosion study. These seven watersheds are Mud Brook, Brandywine Creek, Tinkers Creek, Chippewa Creek, Furnace Run, Yellow Creek, and the local drainage of the Cuyahoga River. Studies for five of the seven subwatersheds have been completed and the results are discussed below. Studies for the remaining two subwatersheds of Brandywine Creek and Yellow Creek will be conducted during Stage 3 planning if the recommendation of this report is to continue into Stage 3. The subwatershed boundaries are shown on Plate A3-1 in Appendix I. Plates A3-2 through A3-8 are land use maps for the five completed subwatersheds which were produced by the Ohio Department of Natural Resources from their Ohio Capability Analysis Program (OCAP). (OCAP is a computerized information system of natural resource data such as land use, soil type, topography, water resources, etc. and is recorded for 1.5-acre cells throughout the State of Ohio. The system also has the ability to analyze and map this information.)

The Environmental Assessment Computer Program (EACP), developed by the SCS, Midwest Technical Service Center, was used in this study to determine the quantity of gross erosion and resultant critical erosion areas from diffuse nonpoint sources of erosion. The basic tool used in the Environmental Assessment Computer Program is the Universal Soil Loss Equation (USLE). The USLE is an empirical formula, developed at the Agricultural Research Service - U. S. Department of Agriculture, that groups the numerous interrelated physical and management parameters that influence the rate of erosion into six factors that can be expressed numerically. Although there are numerous reservations regarding the use of this equation for large basin studies, the equation is recognized as the most reliable method of quantifying potential soil movement that is currently available.

The USLE estimates the quantity of soil detached or dislodged from the land surface by raindrop action and the resultant runoff. It does not, however, measure or calculate the delivery of the eroded soil particle to a stream system. Therefore, delivery rates for each land use encountered in the study area were estimated based on field observations made while conducting the diffuse nonpoint source erosion study. These estimated delivery rates ranged from 10 percent of the quantity of soil detached from the soil surface (as estimated by the USLE) to 70 percent.

The Environmental Assessment Computer Program was applied to a representative sample of the land area in each subwatershed and, based on the established individual sampling rates, the results were expanded for the entire subwatershed. The average basin-wide sampling rate was 17.85 percent. Plate A3-9 in Appendix I shows the location of the Primary Sampling Units for each subwatershed. (Primary Sampling Units are randomly selected squares or land units with approximately 2,000 feet to a side and are the land units that were actually inventoried.)

The results of the studies indicated that sheet and rill erosion from diffuse nonpoint sources of erosion is a very serious problem in the five subwatersheds which were studied for this report. As shown on Table 14, approximately 880,000 tons of sediment (or 590,000 cubic yards) is produced from sheet and rill erosion annually. Of this volume, 850,000 tons (or 570,000 cubic yards) is produced from critically eroding areas (areas which have actual sediment dislodgment above the tolerable soil loss value (the maximum rate of soil erosion expressed in tons per acre per year that will permit a high level of crop productivity to be sustained economically and indefinitely)). These critically eroding areas occur on only 24,000 acres, or 16 percent of the total area. All other areas with erosion rates less than the tolerable soil loss value contribute an insignificant volume of sediment (four percent of the total volume) and can be deleted from further consideration.

As indicated on Table 14, the critically eroding areas in the local drainage subwatershed contribute the largest volume of sediment (approximately 366,000 tons per year or 43 percent of the total volume). This is very significant since the sediment load that it contributes to the river has an immediate impact due to its proximity. Critically eroding areas in Mud Brook subwatershed contribute the smallest volume of sediment (approximately 57,000 tons per year). However, this volume still represents a serious condition, especially when compared to the annual streambank erosion occurring in the study area as previously discussed.

It is estimated that of the 850,000 tons of sediment produced from critically eroding areas, 530,000 tons (or 350,000 cubic yards) is delivered to the Cuyahoga River system annually. In addition, because only the smaller suspended soil particles reach the river system, it is estimated that 100 percent of this volume reaches Cleveland Harbor. By comparing this volume of sediment delivered to the river system with the 860,000 cubic yards of sediment annually dredged from Cleveland Harbor, it can be concluded that the five subwatersheds studied for this report account for 41 percent of the total volume of sediment dredged. Therefore, in order to significantly reduce dredging costs at Cleveland harbor, an effective erosion control program must be implemented on the critically eroding areas in these five subwatersheds.

Plates A3-10 to A3-30 in Appendix I are the OCAP maps produced by ODNR which show the location of potential critically eroding areas in the five subwatersheds studied for this report. These plates are grouped into sets of

Table 14 - Summary of Total Dislodged Sediment vs. Total Sediment Dislodged from Critical Areas 1/

Subwatershed	Total Tons of Sediment Dislodged/Year	Total Subwatershed Acreage	Total Tons of Sediment Dislodged from Critical Areas/Year	Total Critical Area Acreage
Mud Brook	60,871	18,752	57,317	1,395
Tinkers Creeek	173,098	54,784	160,499	5,750
Chippewa Creek	88,607	11,328	86,719	1,804
Furnace Run	180,507	11,328	175,341	2,583
Local Drainage	376,035	60,672	366,213	12,922
Total Area	879,118	156,864	846,089	24,454
	say 880,000 (or 590,000 cy/yr 2/)	say 157,000	say 850,000 3/4/ (or 570,000 cy/yr 2/)	say 24,000 5/

1/ Critical areas are defined as those areas which have actual sediment dislodgement above the tolerable soil loss value.

2/ Assumed unit weight of 110 lbs. per cubic foot.

3/ Of this 850,000 tons of sediment (570,000 cy) it is estimated that 530,000 tons (or 350,000 cy) is delivered to the Cuyahoga River system annually.

4/ Ninety six percent of the total sediment dislodged.

5/ Sixteen percent of the total area acreage.

three (one set per subwatershed). The first plate of each set locates the potential critical erosion areas on a USGS topographic map. The next two plates of each set show the soil type and land use for each eroding area, respectively.

The OCAP maps were produced by having the OCAP computer scan its land use and soil type data base and map out those areas that had the combinations of land use and soil type that characterized the critical erosion areas. These critical combinations were formulated from the data developed from the diffuse nonpoint source erosion study, and are different for each subwatershed. It should be noted, however, that due to the differences in land use catagories between the OCAP system and the EACP system (the system used in the erosion study) some modifications were required. These modifications are discussed in detail in Appendix A. In addition, because of these modifications and because the nonpoint source erosion studies indicated that other variables (which are not included in the OCAP computer data base) were also important in characterizing critical erosion areas, these maps should be interpreted as potential areas of critical erosion only.

Table 15 presents a summary of the sheet and rill erosion occurring on critical eroding areas in the five subwatersheds studied for this report by land use. As indicated, the majority of the sediment produced (66 percent) occurs on woodland land use, primarily in the Furnace Run and local drainage subwatersheds. These areas exhibit a high rate of erosion for the following reasons: (1) all the soils that are eroding are composed of silt and clay loams which are highly erodible; (2) the soils are on very steep slopes which are subject to slipping; and (3) there is an absence of understory canopy and litter duff on the ground surface particularly where the dominant forest species are maple, ash and tulip-poplar. It appears that the lack of understory canopy and litter duff (which act together to protect the forest floor from erosion) is the most significant variable affecting the high rates of erosion. Other woodland areas with the same soil types and slopes were sampled which had significantly lower erosion rates. These areas had dominant forest species of either oak, hemlock or white pine which provided an understory canopy and an accumulation of litter duff on the forest floor.

Because of the significant amount of sheet and rill erosion occurring in woodland areas, the U. S. Forest Service and ODNR-Division of Forestry were contacted in the summer of 1978 to obtain their views on this unique situation. Although some reservations were expressed about the accuracy of the numerical values calculated from the Universal Soil Loss Equation, it was recognized that serious erosion is occurring in the woodland area. Both agencies recommended that further study be conducted, particularly in the Furnace Run subwatershed, to verify the accuracy of the numerical results. In particular, they recommended the following:

(1) A streambank erosion study be conducted in Furnace Run and Wheatley Run (a tributary to Furnace Run).

(2) Identify and quantify gully erosion (identifiable nonpoint sources) along Wheatley Run.

(3) Reevaluate the volume of sheet and rill erosion occurring in Furnace Run subwatershed relative to the above findings.

These recommended study programs will be conducted during Stage 3 planning if the recommendation of this report is to continue into Stage 3.

Pertinent correspondence from these two agencies outlining this proposed study program are included in Appendix G - "Pertinent Correspondence" as Exhibits G-4 and G-5.

The Universal Soil Loss Equation (USLE), the basic tool used in the Environmental Assessment Computer Program to estimate sheet and rill erosion, is an empirical formula that groups the numerous interrelated physical and management parameters that influence the rate of erosion into six major factors that can be expressed numerically. Although research has supplied information from which at least approximate values may be obtained, selection of these values relies on a subjective evaluation of the physical conditions of the site under study by field personnel. Therefore, the figures presented in this report may be at best only a relative indicator of the seriousness of the erosion problem. However, as previously stated, the Universal Soil Loss Equation is recognized as the most reliable method of quantifying potential soil movement that is currently available.

It should also be noted that the Universal Soil Loss Equation does not estimate the sediment loss due to wind erosion, which is of particular concern on agricultural land. However, because of the limited amount of agricultural land in the watershed (less than 10 percent in the five subwatersheds studied for this report), and because the majority of the soil types present in the watershed are moderately cohesive soils, wind erosion is not a significant problem and was therefore not investigated for this Preliminary Feasibility Report.

(3) Identifiable Nonpoint Sources of Erosion - A separate study program was used to identify and quantify identifiable nonpoint sources of erosion (gully erosion on disturbed areas). For this study program, aerial photos from the years 1936-1937, 1951, 1969, 1974, and 1977 were extensively used to identify these identifiable nonpoint sources of erosion. This aerial photo interpretation process was supplemented with field observations made while collecting the field data required by the Environmental Assessment Computer Program. In addition, identification of these source areas was confined to the Standard Project Flood area for the Cuyahoga River. The reason for this decision was that the sediment produced in these source areas, due to their proximity to the river channel, is generally delivered directly to the river and causes an immediate impact on the river system.

Thirty-six identifiable nonpoint sources were identified by this aerial photo interpretation process and their locations are shown on Plates A3-31 and A3-32 in Appendix I. Each source area is identified by two sets of numbers. The first set of numbers refers to the river mile where the source area is located. The second set of numbers refers to the particular source area within that river mile. For example, site 14-1 is river mile 14 and source area one.

Due to time constraints, the quantity of sediment produced by these source areas was not determined for this Preliminary Feasibility Report. Quantities will be determined after each site is visited in the fall of 1979 and the required field data is collected if the recommendation of this report is to continue into Stage 3 planning.

Table 15 - Summary of Critical Erosion Areas by Land Use 1/

Land Use	Total Tons of Sediment Dislodged from Critical Areas/Year	Delivery Rate (Percent)	Delivered Tons/Year	Acres
Commercial-Industrial	15,406	50	7,703	1,011
Community Services	20,979	30	6,293	910
Cropland	12,150	20	2,430	750
Pastureland	1,383	10	139	206
Recreation Land	49,873	70	34,912	440
Transportation Land	1,562	50	781	247
Wildlife Land	42,837	40	17,135	1,853
Woodland	560,593	70	392,416	15,454
Other Land	125,472	50	62,736	2,248
Residential Land	15,834	30	4,749	1,335
Total	846,089		529,294	24,454 2/
	say 850,000		say 530,000	say 24,000

1/ Includes data only for the five subwatersheds of Mud Brook, Furnace Run, Chippewa Creek, Tinkers Creek and the local drainage of the Cuyahoga River.

2/ Sixteen percent of the five subwatershed areas.

15. MANAGEMENT MEASURES (STREAMBANK EROSION CONTROL)

All possible management measures available to solve a given water resource related problem must be identified during the initial stage of any study. These management measures are then combined into different alternative plans of improvement and evaluated. Based on the results of this evaluation the best alternative plan is then identified.

Management measures identified for this Preliminary Feasibility Report to control streambank erosion were divided into two main categories: (1) nonstructural measures; and (2) structural measures. In addition, within each category two basic concepts or approaches were investigated. The first approach, and the approach favored by local interests, involves controlling streambank erosion at its source. The second approach involves reducing the impact of streambank erosion on downstream interests. The specific management measures that were identified and evaluated for this report are discussed below.

a. Nonstructural Measures for Controlling Streambank Erosion

(1) Public Acquisition - Public ownership of all streambanks subject to erosion.

(2) Simple Treatment - Stabilizing eroding streambanks with vegetation.

(3) Management Treatment - Maintaining the existing vegetation cover on streambanks that are currently stable to prevent future streambank erosion (the existing vegetation cover is the reason why these streambanks are currently stable).

b. Structural Measures for Controlling Streambank Erosion

(1) Armoring Treatment - Stabilizing eroding streambanks with stone riprap.

(2) Gabions - Rock filled wire enclosures placed against the eroding streambank.

(3) Groins - Stone dikes placed perpendicular to the eroding streambank.

(4) Fences - Similar to groins except that the dike is constructed of wooden slats.

(5) Auto Bodies - Stabilizing eroding streambanks by lining the banks with discarded auto bodies.

(6) Old Tires - Stabilizing eroding streambanks by lining the banks with discarded automobile tires.

(7) Bulkheads - A vertical wall constructed of stone, concrete, or pilings.

(8) Bank Reconstruction - Reconstructing a streambank to its original height to prevent flood plain scour.

(9) Trash and Bar Removal - Removal of trash and bedload bar buildup where it increases the rate of streambank erosion.

(10) Flow Diversions - Constructing a new flow channel to carry above average stream flow which is responsible for the majority of streambank erosion (normal flow would still be carried by the original stream channel).

(11) Settling Basin - A large basin constructed within the stream which reduces the velocity of the sediment-laden flow and allows the sediment to settle out.

16a. GENERAL FORMULATION AND EVALUATION CRITERIA (STREAMBANK EROSION CONTROL)

Federal policy on multiobjective planning, derived from both legislative and executive authorities, establishes and defines the national objectives for water resource planning, specifies the range of impacts that must be assessed, and sets forth the conditions and criteria which must be applied when evaluating plans. Plans must be formulated to meet the needs of the area with due regard to benefits and costs, both tangible and intangible, and the effects on the ecology and social well-being of the community.

The formulation of a plan, including the screening of alternatives, must of necessity be within the context of an appropriate framework and set of criteria. The planning framework is established in the Water Resource Council's "Principles and Standards for Planning Water and Related Land Resources," which requires the systematic preparation and evaluation of alternative solutions to problems, under the objectives of National Economic Development (NED) and Environmental Quality (EQ). The process also requires that the impacts of a proposed action be measured and the results displayed or accounted for in terms of contributions to four accounts: NED, EQ, Regional Development (RD), and Social Well-Being (SWB). The formulation process must be conducted without bias as to structural and nonstructural measures.

Within the structure of the overall planning framework other more specific criteria relative to general policies, technical engineering, economic principles, social and environmental values and local conditions must be established. These criteria, noted as "Technical," "Economic," "Socioeconomic and Environmental," and "Other" are discussed below.

a. Technical Criteria - As previously discussed, the Buffalo District entered into an Interagency Support Agreement with the U. S. Soil Conservation Service (SCS) in January 1977. As part of this Interagency Agreement, the SCS developed a series of alternative plans of improvement to control streambank erosion. The technical criteria under which these plans were formulated, therefore, reflect SCS practices, regulations, and technical manuals. If the recommendation of this report is to continue into Stage 3 planning, however, modifications to these technical criteria will be required to reflect Army Corps of Engineers criteria. The technical criteria established for this report are as follows:

(1) Streambank protective works will terminate at the top of the existing streambank.

(2) It is assumed that if the existing rate of annual lateral recession (the lateral distance on eroding streambank recedes in one year) is less than or equal to 0.4 feet per year, simple treatment will prevent future streambank erosion. Conversely, if the existing rate of annual lateral recession is greater than 0.4 feet per year structural measures will be required to control streambank erosion.

(3) The design of treatment methods for controlling streambank erosion will be based on one set of "average" conditions.

(4) Design flow velocity will be 10 feet per second (the average channel velocity for the Intermediate Regional Flood at Sagamore Road (river mile 18.6) of 6.6 feet per second multiplied by a safety factor of 1.5 (see Appendix B)).

(5) Bank reconstruction will be limited to those areas where topsoil stripping operations have lowered the existing streambank. The purpose of this measure will be to prevent overbank flow and resultant flood plain scour. The reconstructed bank will be constructed to its original height which is assumed to be the same height as the opposite channel bank.

b. Economic Criteria - The economic criteria established for this report are as follows:

(1) Tangible benefits should exceed project economic costs.

(2) Each separable unit of improvement or purpose should provide benefits at least equal to its cost unless justifiable on a noneconomic basis.

(3) Each plan, as ultimately formulated, should provide the maximum net benefits possible within the formulation framework.

(4) The costs for alternative plans of improvement should be based on preliminary layouts, estimates of quantities, and 1979 unit prices.

(5) The benefits and costs should be in comparable economic terms to the fullest extent possible.

(6) A 50-year economic life and 7-1/8 percent interest rate are used for the economic evaluation.

(7) The base case for comparison of alternative plans is the "do-nothing" (no-action) plan.

c. Socioeconomic and Environmental Criteria - The criteria for socioeconomic and environmental consideration in water resource planning are prescribed by the National Environmental Policy Act of 1969 (PL 91-190) and Section 122 of the River and Harbor Act of 1970 (PL 91-611). These criteria prescribe that all significant adverse and beneficial economic, social, and environmental effects of planned developments be considered and evaluated during plan formulation.

d. Other Criteria - In addition to the criteria discussed above, the following criteria were also established for this report:

(1) Excavated Material Disposal - For this study, it is assumed that excavated material from construction of streambank protective measures would be placed in nearby open fields that are less than one mile from the construction site. A sufficient amount of contingency and cost is included in the cost estimates for landscaping and reseeding the spoil disposal areas.

(2) Mitigation - There is insufficient environmental data available at this time to determine the need for mitigation or the type of mitigation that might be required. Therefore, plans or costs for mitigation are not included in the estimates for this Stage 2 report. If the recommendation of this report is to continue into Stage 3 planning, the required environmental data will be collected and analyzed and a suitable mitigation plan will be developed.

16b. ITEMS OF LOCAL COOPERATION

Formal assurances of local cooperation must be furnished by a municipality or public agency fully authorized under State laws to give such assurances and financially capable of fulfilling all items of local cooperation. The following items of local cooperation were established for this Preliminary Feasibility Report:

(a) Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction and subsequent operation and maintenance of the project including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of spoil and necessary retaining dikes, bulkheads, and embankments therefore, or the costs of such retaining works. In acquiring lands, easements, and rights-of-way for construction and subsequent operation and maintenance of the project comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, approved 2 January 1971, and uniform affected persons of pertinent benefits, policies and procedures in connection with said Act.

(b) Hold and save the United States free from damages due to the construction works except damages due to the fault or negligence of the United States or its Contractors.

(c) Accomplish without cost to the United States such relocations or alterations of utilities as necessary for project purposes.

(d) Bear all costs of maintenance, operation and replacement of these modifications for streambank erosion control.

17. DEVELOPMENT OF ALTERNATIVE PLANS (STREAMBANK EROSION CONTROL)

Within the prescribed planning framework and established criteria, possible solutions were identified and will be evaluated in a three-stage iterative process to address the needs of the study area and the overall planning objectives. Each stage includes the four functional planning tasks of problem identification, formulation of alternatives, impact assessment and evaluation. Each stage contains essentially the same sequence of tasks but emphasis shifted as the process proceeded.

This document reports the results of the Stage 2 evaluation. The level of study performed is consistent with the Stage 2 objective of evaluating a broad range of possible solutions and identifying the best general plan (or plans) for controlling streambank erosion in the study area (Cuyahoga River Basin between Independence (river mile 13.8) and Old Portage (river mile 40.25)).

The primary water resources need for which a solution is sought under this authority is implementation of measures for streambank erosion control. As possible solutions to addressing this need the following eight structural and/or nonstructural conceptual alternatives were identified during the initial phase of this preliminary feasibility investigation in addition to the "no-action" option:

(a) Alternative Plan No. 1 (Total Streambank Stabilization) - Stabilizing all eroding streambanks with structural and nonstructural measures.

(b) Alternative Plan No. 2 (Critical Area Streambank Stabilization) - Stabilizing the major areas of streambank erosion which produce the majority of the sediment load with structural and nonstructural measures.

(c) Alternative Plan No. 3 (Settling Basin) - Construction of a settling basin as proposed in the "First Interim Report for the Cuyahoga River Restoration Study" to remove sediment upstream of the navigation channel at Cleveland Harbor.

(d) Alternative Plan No. 4 (No Action (Do Nothing) Plan)

(e) Alternative Plan No. 5 (Land Acquisition) - Acquire all land subject to streambank erosion and allow natural meandering of the stream.

(f) Alternative Plan No. 6 (Total Streambank Stabilization - Nonstructural) - Stabilizing all eroding streambanks with simple treatment only.

(g) Alternative Plan No. 7 (Total Streambank Stabilization - Structural) - Stabilizing all eroding streambanks with structural measures only.

(h) Alternative Plan No. 8 (Critical Area Streambank Stabilization - Nonstructural) - Stabilizing the major areas of streambank erosion which produce the majority of the sediment load with simple treatment only.

(i) Alternative Plan No. 9 (Critical Area Streambank Stabilization - Structural) - Stabilizing the major areas of streambank erosion which produce the majority of the sediment load with structural measures only.

18. INITIAL ITERATION OF ALTERNATIVES (STREAMBANK EROSION CONTROL)

Preliminary evaluation and assessment of the eight structural and/or nonstructural conceptual alternatives, in terms of their contributions to the planning objectives and accounts, indicated that three options warranted further assessment and evaluation. These options are: Alternative Plan No. 1 (Total Streambank Stabilization); Alternative Plan No. 2 (Critical Area Streambank Stabilization); and Alternative Plan No. 3 (Settling Basin). In addition, Alternative Plan No. 4 (No Action (Do Nothing) Plan) was also carried forward as a basis of comparison of the above structural and nonstructural plans. These four intermediate alternatives (including no action) are discussed in Section D of the Main Report - "Assessment and Evaluation of Preliminary Plans."

Alternative Plans No. 5 through 9 were eliminated from further consideration for the following reasons. Alternative Plan No. 5 (Land Acquisition) was eliminated from further consideration because it would not meet the planning objective of controlling streambank erosion. Alternative Plans No. 6 (Total Streambank Stabilization - Nonstructural) and No. 8 (Critical Area Streambank Stabilization - Nonstructural) were eliminated from further consideration because nonstructural measures (simple treatment) would not control streambank erosion in areas which have an existing rate of annual lateral recession greater than 0.4 feet per year. These areas account for approximately 70 percent of the eroding streambanks in the study area. Alternative Plans No. 7 (Total Streambank Stabilization - Structural) and No. 9 (Critical Area Streambank Stabilization - Structural) were eliminated from further consideration because of economic and environmental considerations. Economics dictated that nonstructural measures (simple treatment) be utilized wherever possible since its cost was less than structural streambank stabilization techniques. In addition, the USF&WL Service opposes these plans because the potential adverse impacts to the fish and wildlife resources of the area are so great.

In addition to eliminating Alternative Plans No. 5 through 9 from further consideration, preliminary evaluation and assessment also indicated that the following general management measures should be eliminated from further consideration. Public acquisition was eliminated because it would not satisfy the planning objective of controlling streambank erosion. Gabions, groins, and bulkheads were eliminated from further consideration because their construction costs were greater than armoring treatment. Armoring treatment will also blend into the surrounding area and present a more aesthetically pleasing appearance. Auto bodies, old tires, and fences were eliminated from further consideration because of their obvious adverse visual impact to scenic enjoyment of the river system. This impact has become more significant in recent years with the establishment of the Cuyahoga Valley National Recreation Area (CVNRA) and its emphasis on scenic enjoyment of the river valley. Flow diversions were also eliminated from further consideration because it violates the stated management policies of the National Park Service for administration of the CVNRA.

19. FORMULATION OF MANAGEMENT PROGRAMS FOR UPLAND EROSION CONTROL

a. General - Erosion and sedimentation is a very serious problem in the upland area (the 303 square-mile drainage basin of the Cuyahoga River between Independence (river mile 13.8) and Old Portage (river mile 40.25)). For example, sheet and rill erosion (diffuse nonpoint sources) in the five subwatersheds studied for this report produce approximately 880,000 tons of sediment annually (see Table 14). Of this volume, 850,000 tons is produced from critically eroding areas (areas which have actual sediment dislodgement above the tolerable soil loss value (the maximum rate of soil erosion expressed in tons per acre per year that will permit a high level of crop productivity to be sustained economically and indefinitely)). These critically eroding areas occur on only 24,000 acres, or 16 percent of the total area. In addition, it is estimated that of the 850,000 tons of sediment produced from these critically eroding areas, 530,000 tons is delivered to the Cuyahoga River system annually and requires maintenance dredging at Cleveland Harbor. This volume of sediment accounts for approximately 41 percent of the total volume of sediment annually dredged. Therefore, in order to significantly reduce dredging costs at Cleveland Harbor, an effective erosion control program must be implemented in the upland area.

Because of the seriousness of the erosion and sedimentation problems in the upland area, the Soil Conservation Service, as part of their Interagency Agreement with the Buffalo District, developed a series of management programs to control erosion in the upland area. Implementation of these management programs must, however, be pursued by local interests. As previously discussed, Corps of Engineers policy prohibits active participation in improvements on privately owned land. The Corps can, however, offer encouragement to local interests who desire to implement erosion control programs in the upland area.

The management programs developed by the SCS for upland erosion control were formulated for the following reasons: (1) to inform local interests as to the types of general treatment measures that would be required to control erosion in the upland area; and (2) the magnitude of the costs that would be involved. Therefore, the formulation and evaluation criteria under which these programs were developed differ from the criteria used to develop streambank erosion control plans whose implementation will be pursued by the Corps of Engineers under the existing study authority. For example, an array of alternative management programs were not developed for controlling sheet and rill erosion (diffuse nonpoint sources) in the seven subwatersheds within the upland study area. Rather, only one management program was developed for each subwatershed which, based on SCS experience with similar types of projects, is both engineeringly feasible and effective in erosion control. The specific formulation and evaluation criteria under which these management programs were developed are discussed in subsection C of this paragraph.

b. Management Measures - The management programs that will be developed in this report to control erosion in the upland area (the 303 square-mile drainage basin) consist of various combinations of Best Management Practices (BMP's) as detailed in the SCS "Technical Guide" and a publication entitled "Water Management and Sediment Control for Urbanizing Areas" SCS, Columbus, Ohio (June 1978). BMP's are defined for this report as those practices that will prevent or reduce the sediment load generated from diffuse and identifiable nonpoint sources of erosion. As previously discussed, these sources of sediment contribute a significant portion of the sediment load being transported by the Cuyahoga River.

The BMP's identified in this Stage 2 investigation were grouped into three main categories: (1) BMP's that improve the existing ground cover; (2) BMP's that reduce the overland flow velocity of storm runoff; and (3) BMP's that lessen the impact of sediment produced by erosion on downstream areas. These three categories are briefly reviewed below and a detailed discussion is included in Appen ix C - "Formulation of Erosion Control Alternatives."

(1) <u>BMP's That Improve the Existing Ground Cover</u>

(a) <u>Critical Area Stabilization (Temporary or Permanent Vegetation)</u> - Stabilizing eroding areas by establishing a temporary or permanent vegetation covering. (The vegetation covering acts as a buffer, protecting the soil surface from the erosive force of the raindrop and resultant runoff.)

(b) <u>Conservation Cropping System</u> - Protecting cropland areas when the cash crop does not afford adequate protection. It involves management measures such as no tillage and minimum tillage and planting of temporary cover during periods when no cash crops are grown.

(c) <u>Pasture and Hayland Planting</u> - Reestablishing pasture and hayland species that die out due to natural or man-made causes.

(d) <u>Heavy Use Area Protection</u> - Providing a protective ground cover (concrete, asphalt, gravel, sawdust, woodchips, etc.) in heavy use areas such as recreation land and commercial-industrial land.

(e) <u>Woodland Site Preparation</u> - Preparing an existing woodland area for new tree planting.

(f) <u>Tree Planting</u> - Planting tree species such as oak, hemlock, or white pine which have slow decaying litter duff and which promote the establishment of an understory canopy. (As previously discussed, litter duff and an understory canopy act together to protect the forest floor from erosion.)

(g) <u>Woodland Improvement</u> - Selective thinning of undesirable tree species (maple, ash, and tulip-poplar) to encourage the growth of preferred tree species (oak, hemlock, and white pine) which exist in the area as seedlings.

(2) <u>BMP's That Reduce Overland Flow Velocity</u>

(a) <u>Runoff Diversion (Temporary or Permament)</u> - A drainage channel constructed across the face of the slope on residential and commercial-industrial land currently under construction and on all areas where gully erosion is present. Safe disposal of the collected runoff will be provided by either a new grassed waterway or discharging into an existing drainage channel.

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(b) Grassed Waterway - A drainage channel that follows the slope of the land in order to provide a safe means of disposal of collected runoff water to a receiving stream. This BMP will be used in combination with diversions or in cropland to dispose of runoff collected by crop rows.

(c) Grade Stabilization Structure - A structure to stabilize the outlet of a natural channel or grassed waterway and prevent head cutting. This BMP will be used in combination with grassed waterways, as required, to dispose of collected runoff water into a receiving stream.

(3) BMP's That Lessen the Impact of Sediment Produced by Erosion on Downstream Areas

(a) Sediment (Debris) Basin - There are certain areas in the basin (construction sites, gravel pits, and landfills) where erosion control practices cannot be implemented due to the nature of the site (continuous land disturbance). Therefore, in order to lessen the impact of sediment produced by erosion on downstream areas, sediment (debris) basins were selected for use. A sediment (debris) basin collects sediment-laden runoff and is of sufficient size to allow the sediment to settle out before the runoff is discharged to a receiving stream. This BMP is applicable to both identifiable (gully erosion) and diffuse (sheet and rill erosion) nonpoint sources of erosion.

(4) Institutional Arrangements

The Best Management Practices discussed above do not include the institutional arrangements that will be required to supplement the management programs presented in this report. These institutional arrangements could be in the form of legislation by regional and/or local units of Government or Memoranda of Understanding between Governments and/or agencies at all levels. Legislation could be in the form of ordinances, zoning regulations, and building codes that could cover soil erosion within the jurisdictional boundaries of the instituting unit of Government. These laws or legislative measures can be called several different things, but the most common are cut and fill ordinances, erosion control regulations, and water quality or urban storm water management regulations. In fact, many cities have this type of legislation already adopted. It only lacks the enforcement and training of inspectors to do the job. New legislation in Ohio is also now in effect which allows local Soil and Water Conservation Districts (SWCD) and the Ohio Department of Natural Resources to contact individual landowners who have an erosion problem and to initiate erosion control measures. In addition, the Agricultural Conservation Program (ACP), administered through the U.S. Department of Agriculture's Agricultural Stabilization and Conservation Service (ASCS), provides Federal cost-sharing funds to agricultural land owners who implement conservation practices on their land. Since eligibility requirements for participation and the specific conservation practices that are cost-shared vary from county to county, local interests are advised to contact their local ASCS County Committee for additional details on this program. However, because of the small amount of agricultural land in the study area (less than 10 percent in the five subwatersheds studied for this report), this program will have limited use in controlling upland erosion in the Cuyahoga River Basin.

Memoranda of Understanding are formalized working agreements for mutual assistance between various levels of State, Federal, and local Government. For example, a city may wish to adopt a sediment control ordinance and will request the assistance of the local SWCD. They next agree on a Memorandum of Understanding which may include such items as limits of each agency's work area, reimbursement procedures, case referral procedures, training of enforcement personnel, enforcement procedures, and who will prepare detailed plans, schedules, and cost estimates.

It is expected that implementation of these institutional arrangements can significantly reduce the erosion problems within the jurisdictional area of the local Governments. In fact, they may well be the most important part of a conservation program in the urbanizing areas of the watershed and should be evaluated before implementing the management programs presented in this report.

c. Plan Formulation and Evaluation Criteria - As previously discussed, management programs were formulated to control erosion in the upland area for the following reasons: (1) to inform local interests as to the types of general treatment measures that would be required to control erosion in the upland area; and (2) the magnitude of the costs that would be involved. The formulation and evaluation criteria under which these management programs were developed are as follows:

(1) A separate management program will be developed to control sheet and rill erosion (diffuse nonpoint sources) for each of the seven subwatersheds within the upland component study area.

(2) In developing these management programs to control sheet and rill erosion, BMP's will be implemented only on those areas which presently have a critical erosion problem (areas which have actual sediment dislodgement above the tolerable soil loss value). As previously discussed, all other areas contribute an insignificant volume of sediment and can be deleted from further consideration. (Based on the results of the studies completed for five of the seven subwatersheds within the upland component study area, only 16 percent of the total area presently has a critical erosion problem. Therefore, these management programs will be developed to control sheet and rill erosion on only 16 percent of the total study area.)

(3) Separate management programs will be developed to control gully erosion for each of the 36 identifiable nonpoint sources of erosion which were identified for this report.

(4) The unit cost of each BMP will be based on SCS experience with similar types of projects updated to November 1979 price levels. In addition, prices will be based on "average" conditions. For example, although the cost of constructing a sediment (debris) basin can vary greatly depending on site conditions, for this study it is assumed to be $1,000 per site.

(5) Economic evaluation of the management programs formulated to control erosion in the upland area will be limited to determining the potential reduced dredging requirements at Cleveland Harbor. This potential benefit will indicate if further Federal involvement in upland erosion control is warranted. (This Federal involvement includes, but is not limited to: completing the sheet and rill erosion study (diffuse nonpoint sources) in Brandywine Creek and Yellow Creek subwatersheds; and quantifying the identifiable nonpoint sources of erosion.)

(6) Based on SCS experience, it is assumed that the treatment measures specified for erosion control are self-liquidating. That is, individual landowners will realize benefits equal to or greater than the cost of implementing these treatment measures.

(7) An environmental assessment of the management programs formulated to control erosion in the upland area is not required. It will be the responsibility of the local landowner implementing the erosion control program to

determine whether or not his actions will adversely impact on the environment and, if appropriate, develop a suitable mitigation plan.

(8) It is assumed that local interests will obtain professional assistance in tailoring erosion control plans to specific sites and field conditions. Professional assistance can be obtained from private consultants, the local Soil and Water Conservation Districts, etc.

(9) It is assumed that a reduction in upland erosion, and a corresponding reduction on the volume of sediment delivered to the streams, will not cause an increase in streambank erosion due to sediment starvation.

d. Development of Management Programs for Upland Erosion Control - Management programs to control sheet and rill erosion (diffuse nonpoint sources) were developed for each of the five subwatersheds studied for this report (Mud Brook, Tinkers Creek, Chippewa Creek, Furnace Run, and the local drainage of the Cuyahoga River). These management programs are discussed in Section D of the Main Report - "Assessment and Evaluation of Preliminary Plans." Management programs for Brandywine Creek and Yellow Creek subwatersheds (diffuse nonpoint sources of erosion) and the 36 identifiable nonpoint sources of erosion (gully erosion on disturbed areas) will be formulated following completion of the erosion and sedimentation studies for these source areas if the recommendation of this report is to continue into Stage 3 planning.

e. Role of the Corps of Engineers in Upland Erosion Control - As previously discussed, Corps of Engineers policy prohibits active participation in improvements on privately-owned land (in this instance, the Cuyahoga Valley National Recreation Area is classified as privately-owned land). Therefore, the Corps of Engineers will not implement (construct) the management programs presented in this report for controlling erosion in the upland area. Rather, the Corps will look to other units of Government, such as the National Park Service, the Soil and Water Conservation Districts, State, county, and city Governments, and other local agencies and to individual landowners to implement the management programs.

The Corps views its role as a planning agency and a catalyst. In its role as a planning agency, its goals are to quantify the upland erosion problem, identify the critically eroding areas, and identify techniques that could be implemented by others to reduce erosion of the land surface. In this capacity, the Corps has entered into an Interagency Agreement with the U. S. Soil Conservation Service because of their expertise in these areas. In its role as a catalyst, its goals are to stimulate an awareness in the watershed area as to the erosion problems that exist and the possible measures that can be implemented to control it. These goals have been partially met with the preparation and dissemination of this Preliminary Feasibility Report and will be culminated with the preparation of the Final Feasibility Report if the recommendation of this report is to continue into Stage 3 planning.

20. PLANS OF OTHERS

In order for the Corps of Engineers to effectively develop plans for any water resources project, it is necessary to coordinate these plans with plans being developed by other agencies. Within the Cuyahoga River Basin, agencies that have developed plans for the area include the National Park Service and the Northeast Ohio Areawide Coordinating Agency (NOACA).

As previously discussed, a majority of the study area lies within the boundaries of the Cuyahoga Valley National Recreation Area (CVNRA) administered by the National Park Service. In their "General Management Plan," July 1977, the National Park Service lists the policies which will guide management of the park's natural resources. Throughout the course of this study, informal discussions were held with National Park Service personnel to insure that the alternatives formulated to control erosion were compatible with the stated policies of that agency.

The Northeast Ohio Areawide Coordinating Agency (NOACA) is currently involved in a Section 208 Study (Public Law 92-500) in the Cuyahoga River Basin. The goal of this Study is to identify development and management water quality programs that would control point and nonpoint sources of pollution, thereby reestablishing and maintaining the highest practical water quality in the Basin. As part of this study, NOACA has recently developed a management plan for the area as detailed in the "Northeast Ohio Lake Erie Drainage Basin Water Quality Management Plan" July 1979. As part of this management plan, NOACA has recommended that local Soil and Water Conservation Districts implement Best Management Practices on critically eroding areas (areas which have actual sediment dislodgement above the tolerable soil loss value) within their jurisdictional area. These Best Management Practices are the same as those recommended for use in formulating the management programs that were developed for this report.

SECTION D
ASSESSMENT AND EVALUATION OF PRELIMINARY PLANS

The purpose of this section is to provide the reader of this report with a summary of the engineering design, economic evaluation, and environmental assessment associated with the three structural and nonstructural alternatives that an initial screening of a wide range of possible solutions indicated had the greatest potential for meeting the planning objective of streambank erosion control. These three alternatives are:

Alternative Plan No. 1 (Total Streambank Stabilization)

Alternative Plan No. 2 (Critical Area Streambank Stabilization)

Alternative Plan No. 3 (Settling Basin)

In addition, the basis of comparison for the above structural and nonstructural plans is:

Alternative Plan No. 4 (No Action (Do Nothing) Plan)

This section also provides a summary description of the management programs developed to control sheet and rill erosion (diffuse nonpoint sources) on the five subwatersheds studied for this report (Mud Brook, Tinkers Creek, Chippewa Creek, Furnace Run and the local drainage of the Cuyahoga River) and the associated economic evaluation conducted to determine if further Federal involvement in upland erosion control is warranted. This involvement includes, but is not limited to, the following: (1) completing the diffuse nonpoint source erosion study in Brandywine Creek and Yellow Creek subwatersheds and developing management programs to control this erosion; and (2) quantifying the identifiable nonpoint sources of erosion (gully erosion on disturbed areas) and developing separate management programs to control this erosion.

Appendices B through D of this report provide details of the engineering and economic analyses associated with the alternatives formulated to control streambank erosion and the management programs developed to control sheet and rill erosion in the upland area. These appendices are:

Appendix B - Hydrology and Hydraulic Design

Appendix C - Formulation of Erosion Control Alternatives

Appendix D - Economic Evaluation

21. ALTERNATIVE PLAN NO. 1 (TOTAL STREAMBANK STABILIZATION)

a. Description of Alternative Plan No. 1 - Alternative Plan No. 1 was formulated to control all existing and potential annual streambank erosion and prevent the formation of the seven potential meander changes along the banks of the Cuyahoga River and its six major tributaries within the channel component study area (see Figure 10). The existing sources of annual streambank erosion and the seven potential meander changes were previously located and quantified in Section C of the Main Report.

The results of the studies presented in Section C indicated that annual streambank erosion annually produces about 52,000 cubic yards of sediment (see Table 12). Of this 52,000 cubic yards of sediment, it is estimated that approximately 47,000 cubic yards is transported to Cleveland Harbor and requires yearly maintenance dredging. The studies also indicated that of the 143 miles of streambanks studied for this report (71.5 river/stream miles), only 22.7 miles, or 16 percent of the streambanks were actively eroding. These actively eroding streambanks are dispersed throughout the entire study area. Areas of major streambank erosion were identified between river miles 13.8 to 15.1, 18.0 to 20.0, 22.0 to 25.0, 26.0 to 27.0, and 30.0 to 33.0 on the Cuyhoga River, stream mile 0.0 to 0.8 on Yellow Creek, stream mile 0.0 to 1.5 on Furnace Run, stream mile 1.0 to 2.0 on Brandywine Creek, and between stream miles 1.0 to 2.0 and 11.0 to 12.0 on Tinkers Creek. The studies also indicated that there were seven locations on the Cuyahoga River (river mile 23.3, 25.3, 25.7, 26.1, 34.8(a), 34.8(b), and 39.0) where the existing high rate of annual streambank erosion (annual lateral recession) was likely to produce a change in the course of the river (potential meander change). If these potential meander changes were to occur, they would introduce an additional 125,000 cubic yards of sediment into the river system (see Table 13). The first objective considered in formulating Alternative Plan No. 1 was therefore to control the 22.7 miles of actively eroding streambanks and the seven potential meander changes, and thus prevent the introduction of the resultant sediment load into the river system.

The results of the studies presented in Section C also indicated that there were several sites where damage to local roads and railroad facilities of the Baltimore and Ohio Railroad would occur in the future because of the high rates of annual lateral recession at these locations. Local roads that are endangered occur at river mile 24.6 and 35.0 on the Cuyahoga River. Railroad facilities that are endangered occur at river mile 14.8 and 26.2 on the Cuyahoga River, stream mile 0.4 on Furnace Run and stream mile 0.2 on Yellow Creek. By controlling annual streambank erosion at these sites, damage to the local roads and railroad facilities will also be prevented.

The plan that was formulated to control the 22.7 miles of actively eroding streambanks and the seven potential meander changes consisted of either simple treatment or armoring treatment. Simple treatment was selected to control 7.2 streambank miles, or 32 percent of the eroding streambanks, and armoring treatment was selected for the remaining 15.5 streambank miles, or 68 percent. The specific locations where each type of treatment measure is required are shown on Plates C2-1 to C2-5 in Appendix I.

The selection of simple treatment or armoring treatment was based on the criteria previously outlined. For example, at eroding Reach 16-2 on the Cuyahoga River with an estimated annual lateral recession rate of 0.3 feet per year, simple treatment was selected. Conversely, at eroding Reach 16-1 on the Cuyahoga River with an estimated annual lateral recession rate of 1.5 feet per year, armoring treatment was selected. In all cases, armoring treatment was selected at the locations of the seven potential meander changes.

In addition to the treatment methods outlined above, 1.2 miles of trash and bar removal and 0.7 miles of bank reconstruction were included in Alternative Plan No. 1. Trash and bedload bar buildup was identified as a contributing factor to the high rates of annual lateral recession at several locations. Its removal will therefore aid in protecting the eroding streambanks. The specific locations where trash and bar removal is required are shown on Plates C2-1 to C2-5 in Appendix I. It should be noted, however, that the presently eroding streambank will still require armoring treatment to prevent future streambank erosion. This armoring treatment has been included above.

Bank reconstruction is required to prevent overbank flow in areas where the streambanks have been lowered by topsoil stripping operations. Although the quantity of sediment eroded from these areas during periods of overbank flow was not quantified for this report, it is believed to be significant since these areas have no vegetative cover and are thus susceptible to erosion. The seven specific locations on the Cuyahoga River requiring this type of treatment are shown on Plates C2-1 and C2-2. The required protection on the stream side of the reconstructed bank was based on the existing rate of annual lateral recession at each location. For the reconstructed banks at river mile 16.2, 25.3, and 25.7 on the west bank and at river mile 24.3 on the east bank, armoring treatment will be required because the existing rates of annual lateral recession are greater than 0.4 feet per year and is included above. Since there is presently no annual streambank erosion at river mile 15.5, 24.4, and 25.2 on the west bank, the stream side of the reconstructed bank will be protected with grass.

The second objective considered in formulating Alternative Plan No. 1 was to prevent future streambank erosion in areas where the present rate of bank erosion (annual lateral recession) is negligible or within tolerable limits. Therefore, management treatment was selected for the remaining 120.3 miles of stable streambanks, or 84 percent of the total streambanks studied for this report. This management treatment program would consist of annual maintenance activities on the existing vegetation cover (which is responsible for the negligible bank erosion along these streambanks) and semi-annual inspections of the streambanks to verify that these banks were still stable. If the existing vegetation cover is disturbed in the future, and unstable banks develop, the appropriate treatment method (simmple treatment or armoring treatment) would be identified and implemented.

In conclusion, Alternative Plan No. 1 consists of a plan of action to control the 22.7 miles of actively eroding streambanks and the seven potential meander changes in the study area and a plan of action to insure that future streambank erosion does not occur on the 120.3 miles of presently stable streambanks. A summary of the total required streambank treatment needs is presented in Table 16. In addition, a detailed description of this alternative is presented in Appendix C.

b. Cost Estimate for Alternative Plan No. 1 - The preliminary cost estimate for Alternative Plan No. 1 is presented in Table C2.24 in Appendix C and annual charges are summarized in Table C2.26.

Tables 17 and 18, following, summarize the estimated project costs and annual charges and provide a breakdown of the Federal and non-Federal share of these costs for Alternative Plan No. 1. From these tabulations, it is seen that the total project cost is $8,986,000 (Table 17) and the total annual charges are $821,600 (Table 18).

c. Economic Evaluation of Alternative Plan 1 - The detailed discussion on the projected benefits that would be realized from implementation of Alternative Plan No. 1 is presented in Appendix D - "Economic Evaluation." Benefit categories investigated include: (1) reduced dredging requirements at Cleveland Harbor as a result of controlling annual streambank erosion; (2) reduced dredging requirements at Cleveland Harbor as a result of preventing formation of the seven potential meander charges; (3) land conservation; and (4) flood control. In addition, two benefit scenarios were investigated. Scenario 1 assumes open-lake disposal of dredged material at Cleveland Harbor and Scenario 2 assumes continued diked disposal of dredged material for the 50-year economic life of the project. From Table D2.3 in Appendix D, the total average annual benefit for Alternative Plan No. 1 under Scenario 1 is $304,300 and under Scenario 2 is $456,000.

The benefit categories discussed above do not include the benefits that would be realized for preventing future damage to local roads and railroad facilities. These benefits would consist of costs avoided in repairing the damage and extra transportation costs avoided in rerouting traffic during repair of the damage. As discussed in Section C of the Main Report, one of the economic criteria under which plans of improvement were formulated for this report was that "Each separable unit of improvement or purpose should provide benefits at least equal to its cost unless justifiable on a noneconomic basis." Since benefits realized from preventing future damage to local roads and railroad facilities apply to specific sites, and not to the study area as a whole, they were not included in the determination of the economic efficiency of Alternative Plan No. 1 which address the total study area. If the recommendation of this report is to continue into Stage 3 planning, these benefits will be estimated and included in the economic analysis with Alternative Plan No. 1. However, if the recommendation of this report is to terminate the study for economic or other reasons, separate recommendations will be made for these specific sites.

Table 19, following, summarizes the average annual charges, average annual benefits, net average annual benefits and the benefit-cost ratio for Alternative Plan No. 1. As indicated, net average annual benefits are -$517,300 under Scenario 1 and $-365,600 under Scenario 2. The benefit-cost ratio is 0.37 under Scenario 1 and 0.56 under Scenario 2.

Table 16 - Alternative Plan No. 1: Summary of Required Streambank Treatment Needs - Total Channel Component Study Area 1/

Treatment Method	Miles of Treatment Required
1. Management Treatment	120.3
2. Simple Treatment	7.2
3. Armoring Treatment	15.5
4. Trash and Bar Removal	1.2
5. Bank Reconstruction	0.7

1/ Cuyahoga River (river mile 13.8 to 40.25), Chippewa Creek (stream mile 0.0 to 0.4), Furnace Run (stream mile 0.0 to 1.5), Yellow Creek (stream mile 0.0 to 0.8), Mud Brook (stream mile 0.0 to 0.2), Brandywine Creek (0.0 to 11.6, including Indian Creek - stream mile 0.0 to 3.2), and Tinkers Creek (stream mile 0.0 to 27.3).

Table 17 - Estimate of Total Project Cost for Alternative Plan No. 1 and Federal and Non-Federal Share 1/

Item	Amount	Total
	$	$
1. Lands 2/	405,000	
2. Management Treatment	0 3/	
3. Simple Treatment	52,000	
4. Armoring Treatment	5,256,000	
5. Trash and Bar Removal	59,000	
6. Bank Reconstruction	33,000	
7. Contingencies	1,161,000	
8. Engineering and Design	1,184,000	
9. Supervision and Administration	836,000	
		8,986,000 4/
Federal Share: (Items 2, 3, 4, 5, 6, 7, 8, and 9)	8,581,000	
		8,581,000
Non-Federal Share: (Item 1)	405,000	
		405,000

1/ Cost estimate based on SCS experience with similar type projects with unit costs updated to November 1979 price levels.

2/ Preliminary estimate of the cost of obtaining a 25-foot wide maintenance and construction easement on lands outside the boundaries of the Cuyahoga Valley National Recreation Area.

3/ Management treatment consists of annual maintenance activities only.

4/ Cost estimate does not include costs for mitigation of adverse environmental impacts which may be required for Alternative Plan No. 1. Costs for mitigation will be included in the Final Feasibility Report, as appropriate.

Table 18 - Estimated Investment Cost and Annual Charges for Alternative Plan No. 1 1/

Item	Federal	Non-Federal	Total
	$	$	$
First Cost	8,581,000	405,000	8,986,000
Interest During Construction	0	0	0
Total Project Costs	8,581,000	405,000	8,986,000
Annual Charges			
Interest	611,400	28,900	640,300
Amortization	20,300	1,000	21,300
Maintenance 2/	0	160,000	160,000
Total	631,700	189,900	821,600

1/ Based on November 1979 price levels, 7-1/8 percent interest rate and a 50-year economic life.

2/ 100 percent non-Federal.

Table 19 - Summary of Benefits and Cost for Alternative Plan No. 1

	Average Annual Charges ($ Per Yr.)	Average 1/ Annual Benefits ($ Per Yr.)	Net 1/ Average Annual Benefits ($ Per Yr.)	Benefit-Cost 1/ Ratio
Scenario 1 2/	821,600	304,300	-517,300	0.37
Scenario 2 3/	821,600	456,000	-365,600	0.56

1/ Does not include the average annual benefits that would be realized from preventing damage to local roads and railroad facilities.

2/ Scenario 1 assumes open-lake disposal of dredged material at Cleveland Harbor.

3/ Scenario 2 assumes continued diked disposal of dredged material at Cleveland Harbor.

d. Environmental Features/Assessment of Alternative Plan No. 1 - The environmental features/assessment of Alternative Plan 1 is presented in paragraph 25.

e. Conclusion - It is the policy of the Corps of Engineers not to recommend projects for implementation when the costs of the project exceed the benefits that would be realized (benefit-cost ratio less than 1.0) unless there are overriding considerations of environmental quality, or social impacts warranting a departure from economic (cost-effective) decisions. Therefore, since Alternative Plan No. 1 does not exhibit economic efficiency (benefit-cost ratio less than 1.0 and negative net average annual benefits), it cannot be recommended for implementation unless overriding environmental or social impacts are identified in the environmental assessment of this plan (see paragraph 25).

22. ALTERNATIVE PLAN NO. 2 (CRITICAL AREA STREAMBANK STABILIZATION)

a. Description of Alternative Plan No. 2 - Alternative Plan No. 2 was formulated to control the major areas of annual streambank erosion which produce the majority of the sediment load and prevent the formation of the seven potential meander changes along the banks of the Cuyahoga River and the six major tributaries within the channel component study area (see Figure 10). By treating only those major areas of sediment production, this alternative will minimize the cost of construction while still significantly reducing the total sediment load dredged at Cleveland Harbor from streambank erosion.

The results of the studies presented in Section C of the Main Report indicated that of the 22.7 miles of actively eroding streambanks 13.2 miles, or 58 percent of the eroding streambanks produce the majority of the sediment load derived from annual streambank erosion. These areas are as follows:

(1)	Cuyahoga River:	river mile 13.8 to 15.1
		river mile 18.0 to 20.0
		river mile 22.0 to 25.0
		river mile 26.0 to 27.0
		river mile 30.0 to 33.0
(2)	Furnace Run:	stream mile 0.0 to 1.5
(3)	Yellow Creek:	stream mile 0.0 to 0.8
(4)	Brandywine Creek:	stream mile 1.0 to 2.0
(5)	Tinkers Creek:	stream mile 1.0 to 2.0
		stream mile 11.0 to 12.0

These areas produce 44,000 cubic yards of sediment per year or 85 percent of the total volume. The studies also indicated that there were seven locations on the Cuyahoga River (river mile 23.3, 25.3, 25.7, 26.1, 34.8(a), 34.8(b), and 39.0) where the existing high rate of annual streambank erosion (annual lateral recession) was likely to produce a change in the course of the river (potential meander change). If these potential meander changes were to occur, they would introduce an additional 125,000 cubic yards of sediment into the river system (see Table 13). The only objective considered in formulating Alternative Plan No. 2 was therefore to control the 13.2 miles of eroding streambanks which produce the majority of the sediment load from annual streambank erosion (85 percent) and to prevent the formation of the seven potential meander changes and their resultant sediment load.

The results of the studies presented in Section C also indicated that there were several sites where damage to local roads and railroad facilities of the Baltimore and Ohio Railroad would occur in the future because of the high rates of annual lateral recession at these locations. Local roads that are endangered occur at river mile 24.6 and 35.0 on the Cuyahoga River. Railroad facilities that are endangered occur at river mile 14.8 and 26.2 on the Cuyahoga River, stream mile 0.4 on Furnace Run, and stream mile 0.2 on Yellow Creek. By controlling streambank erosion at these sites, damage to the local roads and railroad facilities will also be prevented.

The plan that was formulated to control the 13.2 miles of eroding streambanks and the seven potential meander changes consisted of the same treatment methods specified for Alternative Plan No. 1 in the areas identified above. For example, between river mile 13.8 to 15.1 on the Cuyahoga River the same treatment methods specified for Alternative Plan No. 1 to control the eroding streambanks were specified for Alternative Plan No. 2. Conversely, between river mile 15.1 to 16.0 no streambank protection was included in Alternative Plan No. 2 since these areas did not produce a significant sediment load. In addition, armoring treatment was included in Alternative Plan No. 2 to prevent the formation of the seven potential meander changes.

Of the 13.2 miles of eroding streambanks protected in this alternative, simple treatment was selected to control 2.8 miles, or 21 percent of the eroding streambanks, and armoring treatment was selected for the remaining 10.4 miles, or 79 percent. In addition, 0.6 miles of armoring treatment was included in Alternative Plan No. 2 to prevent the formation of the four potential meander charges located outside the major sediment production areas of annual streambank erosion. The specific locations where each type of treatment measure is required are shown on Plates C2-6 to C2-10 in Appendix I.

In addition to the treatment methods outlined above, 1.2 miles of trash and bar removal and 0.3 miles of bank reconstruction were included in Alternative Plan No. 2. Trash and bedload bar buildup was identified as a contributing factor to the high rates of annual lateral recession at several locations. Its removal will therefore aid in protecting the eroding streambanks. The specific locations where trash and bar removal is required are shown on Plates C2-6 to C2-10 in Appendix I. It should be noted, however, that the presently eroding streambanks will still require armoring treatment to prevent future streambank erosion. This armoring treatment has been included above.

Bank reconstruction is required for Alternative Plan No. 2 at the locations shown on Plates C2-6 and C2-7. While the main purpose of bank reconstruction for Alternative Plan No. 1 was to prevent overbank flow and resultant flood plain scour, the main purpose of bank reconstruction for Alternative Plan No. 2 is to provide a stable foundation for the armoring treatment specified at these locations. Armoring treatment will prevent existing annual streambank erosion at river mile 24.3 on the east bank and will prevent the formation of potential meander changes at river mile 25.3 and 25.7 on the west bank. All other areas where bank reconstruction was specified for Alternative Plan No. 1 were not included in Alternative Plan No. 2 because of either of the following: (1) they were outside the specified limits of Alternative Plan No. 2; or (2) the existing streambank presently was not eroding.

In conclusion, of the 22.7 miles of actively eroding streambanks identified in this report 13.8 miles, or 61 percent, will be protected in Alternative Plan No. 2. A summary of the total required streambank treatment needs is presented in Table 20. In addition, a detailed description of this alternative is presented in Appendix C.

It should be noted that Alternative Plan No. 2 does not include a provision for inspecting nor implementing future protective measures for the 120.3 miles of presently stable streambanks and the 8.9 miles of eroding streambanks that will not be protected in this scheme. Therefore, if a significant increase in streambank erosion occurs within these areas it will not be detected until it causes an immediate problem to local interests. If this situation occurs local interests are advised to contact the Corps of Engineers for technical assistance.

b. Cost Estimate for Alternative Plan No. 2 - The preliminary cost estimate for Alternative Plan No. 2 is presented in Table C2.25 in Appendix C and annual charges are summarized in Table C2.27.

Tables 21 and 22, following, summarize the estimated project costs and annual charges and provide a breakdown of the Federal and non-Federal share of these costs for Alternative Plan No. 2. From these tabulations, it is seen that the total project cost is $6,202,000 (Table 21) and the total annual charges are $535,500 (Table 22).

c. Economic Evaluation of Alternative Plan No. 2 - The detailed discussion on the projected benefits that would be realized from implementation of Alternative Plan No. 2 is presented in Appendix D - "Economic Evaluation." Benefit categories investigated include: (1) reduced dredging requirements at Cleveland Harbor as a result of controlling annual streambank erosion; (2) reduced dredging requirements at Cleveland Harbor as a result of preventing formation of the seven potential meander charges; (3) land conservation; and (4) flood control. In addition, two benefit scenarios were investigated. Scenario 1 assumes open-lake disposal of dredged material at Cleveland Harbor and Scenario 2 assumes continued diked disposal of dredged material for the 50-year economic life of the project. From Table D2.4 in Appendix D, the total average annual benefit for Alternative Plan No. 2 under Scenario 1 is $262,900 and under Scenario 2 is $396,700. (Note: The average annual benefits stated above do not include the average annual benefits that would be realized from preventing future damage to local roads and railroad facilities.)

Table 20 - Alternative Plan No. 2: Summary of Treatment Required - Total Channel Component Study Area 1/

Treatment Method	Miles of Treatment Required
1. Management Treatment	None
2. Simple Treatment	2.8
3. Armoring Treatment	11.0
4. Trash and Bar Removal	1.2
5. Bank Reconstruction	0.3

1/ Cuyahoga River (river mile 13.8 to 40.25), Chippewa Creek (stream mile 0.0 to 0.4), Furnace Run (stream mile 0.0 to 1.5), Yellow Creek (stream mile 0.0 to 0.8), Mud Brook (stream mile 0.0 to 0.2), Brandywine Creek (0.0 to 11.6, including Indian Creek - stream mile 0.0 to 3.2), and Tinkers Creek (stream mile 0.0 to 27.3).

Table 21 - Estimate of Total Project Cost for Alternative Plan No. 2 and Federal and Non-Federal Share 1/

Item	Amount	Total
	$	$
1. Lands 2/	42,000	
2. Management Treatment	0 3/	
3. Simple Treatment	20,000	
4. Armoring Treatment	3,871,000	
5. Trash and Bar Removal	59,000	
6. Bank Reconstruction	15,000	
7. Contingencies	801,000	
8. Engineering and Design	817,000	
9. Supervision and Administration	577,000	
		6,202,000 4/
Federal Share: (Items 2, 3, 4, 5, 6, 7, 8, and 9)	6,160,000	
		6,160,000
Non-Federal Share: (Item 1)	42,000	
		42,000

1/ Cost estimate based on SCS experience with similar type projects with unit costs updated to November 1979 price levels.

2/ Preliminary estimate of the cost of obtaining a 25-foot wide maintenance and construction easement on lands outside the boundaries of the Cuyahoga Valley National Recreation Area.

3/ Management treatment was not specified for this alternative.

4/ Cost estimate does not include costs for mitigation of adverse environmental impacts which may be required for Alternative Plan No. 2. Costs for mitigation will be included in the Final Feasibility Report, as appropriate.

Table 22 - Estimated Investment Cost and Annual Charges for Alternative Plan No. 2

Item	Federal	Non-Federal	Total
	$	$	$
First Cost	6,160,000	42,000	6,202,000
Interest During Construction	0	0	0
Total Project Costs	6,160,000	42,000	6,202,000
Annual Charges			
Interest	438,900	3,000	441,900
Amortization	14,500	100	14,600
Maintenance 2/	0	79,000	79,000
Total	453,400	82,100	535,500

1/ Based on November 1979 price levels, 7-1/8 percent interest rate and a 50-year economic life.

2/ 100 percent non-Federal.

Table 23, following, summarizes the average annual charges, average annual benefits, net average annual benefits, and the benefit-cost ratio for Alternative Plan No. 2 for Scenario 1 and Scenario 2. As indicated, net average annual benefits are $-272,600 under Scenario 1 and $-138,800 under Scenario 2. The benefit-cost ratio is 0.49 under Scenario 1 and 0.74 under Scenario 2.

d. Environmental Features/Assessment of Alternative Plan No. 2 - The environmental features/assessment of Alternative Plan 2 is presented in paragraph 25.

e. Conclusion - As previously stated, it is the policy of the Corps of Engineers not to recommend projects for implementation when the costs of the project exceed the benefits that would be realized (benefit-cost ratio less than 1.0) unless there are overriding considerations of environmental quality or social impacts warranting departure from economic (cost-effective) decisions. Therefore, since Alternative Plan No. 2 does not exhibit economic efficiency (benefit-cost ratio less than 1.0 and negative net average annual benefits), it cannot be recommended for implementation unless overriding environmental or social impacts are identified in the environmental assessment of this plan (see paragraph 25).

23. ALTERNATIVE PLAN NO. 3 (SETTLING BASIN)

a. General - As previously discussed, during its review of the "First Interim Report" for the Cuyahoga River Restoration Study, the Board of Engineers for Rivers and Harbors (BERH) concluded, among other things, that a settling basin on the Cuyahoga River should also be considered as an early-action program. Accordingly, the Board conducted a public meeting on 19 January 1972, in Cleveland, OH, on the considered modifications. Based on the information presented at this meeting, the Board concluded that local interests were not prepared at that time to provide the required items of local cooperation for the settling basin and noted that substantial environmental issues would have to be resolved before implementing the plan. Local interests also stated their desire for the Corps of Engineers to conduct a detailed basin-wide survey to identify and quantify sources of sediment and to formulate plans of improvements to control erosion at its source rather than at the downstream reach of the river. The Board, therefore, recommended that a settling basin on the Cuyahoga River be given further study and be considered for construction if the environmental issues could be resolved and the items of local cooperation met.

As an alternative to controlling erosion and sedimentation, the settling basin concept was reevaluated for this preliminary feasibility investigation in light of current conditions within the study area. The results of this reevaluation are discussed below following a description of the settling basin concept as originally proposed in the "First Interim Report."

b. Description of Alternative Plan No. 3 - As originally proposed in the "First Interim Report," Alternative Plan No. 3 consisted of a settling basin approximately 5,000 feet in length and 1,000 feet wide on the Cuyahoga River between river mile 8 and 9 (see Figure 11). The final shape of the basin,

Table 23 - Summary of Benefits and Cost for Alternative Plan No. 2

	Average Annual Charges ($ Per Yr.)	Average 1/ Annual Benefits ($ Per Yr.)	Net 1/ Average Annual Benefits ($ Per Yr.)	Benefit-Cost 1/ Ratio
Scenario 1 2/	535,500	262,900	-272,600	0.49
Scenario 2 3/	535,500	396,700	-138,800	0.74

1/ Does not include the average annual benefits that would be realized from preventing damage to local roads and railroad facilities.

2/ Scenario 1 assumes open-lake disposal of dredged material at Cleveland Harbor.

3/ Scenario 2 assumes continued diked disposal of dredged material at Cleveland Harbor.

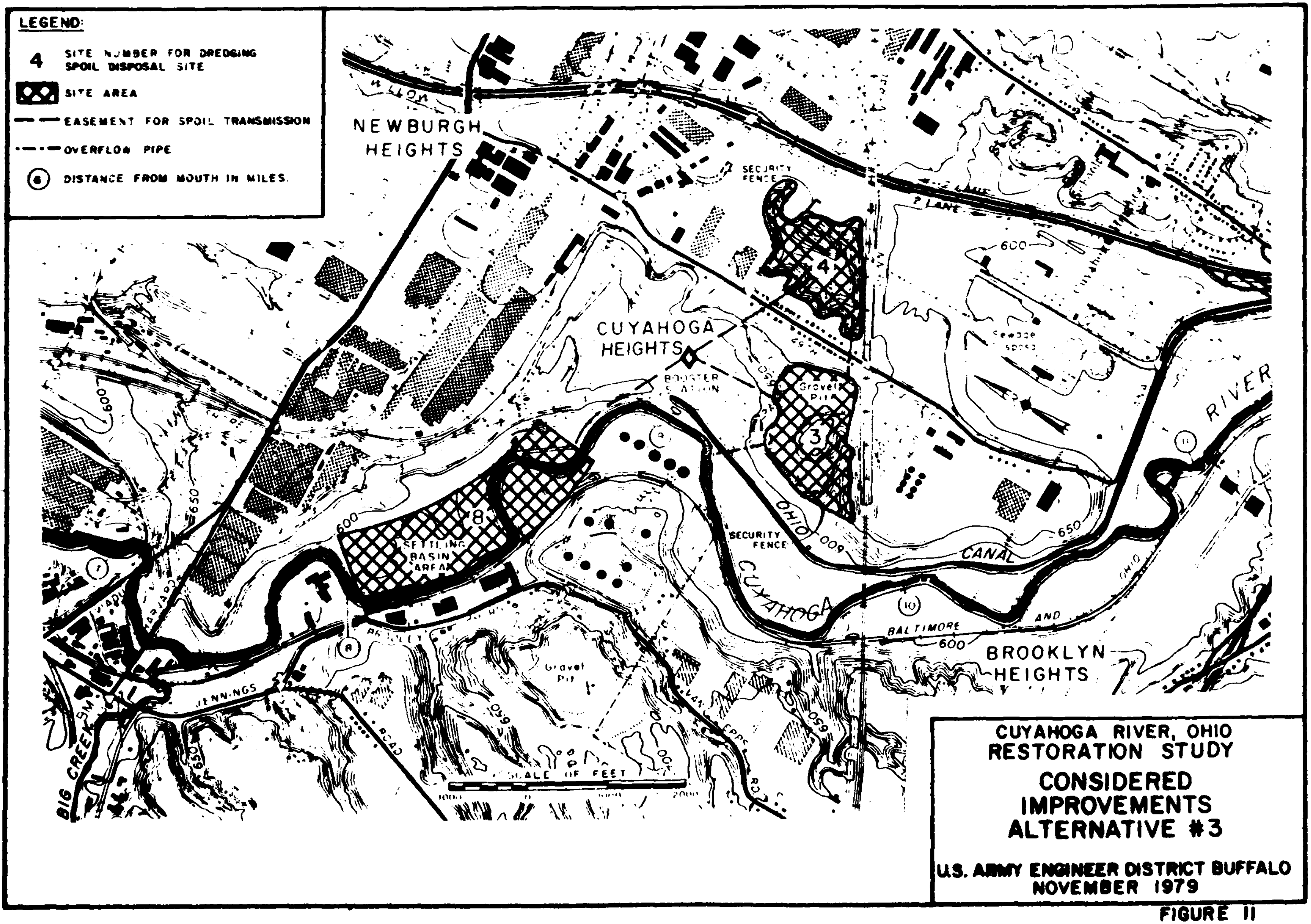
LEGEND:
4 SITE NUMBER FOR DREDGING SPOIL DISPOSAL SITE
SITE AREA
EASEMENT FOR SPOIL TRANSMISSION
OVERFLOW PIPE
DISTANCE FROM MOUTH IN MILES.
NEWBURGH HEIGHTS
CUYAHOGA HEIGHTS
BOOSTER STATION
SECURITY FENCE
Gravel Pit
SETTLING BASIN AREA
CUYAHOGA
OHIO
CANAL
RIVER
BALTIMORE AND OHIO
BROOKLYN HEIGHTS
JENNINGS
BIG CREEK
Gravel Pit
SCALE OF FEET
CUYAHOGA RIVER, OHIO
RESTORATION STUDY
CONSIDERED IMPROVEMENTS ALTERNATIVE #3
U.S. ARMY ENGINEER DISTRICT BUFFALO
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FIGURE 11

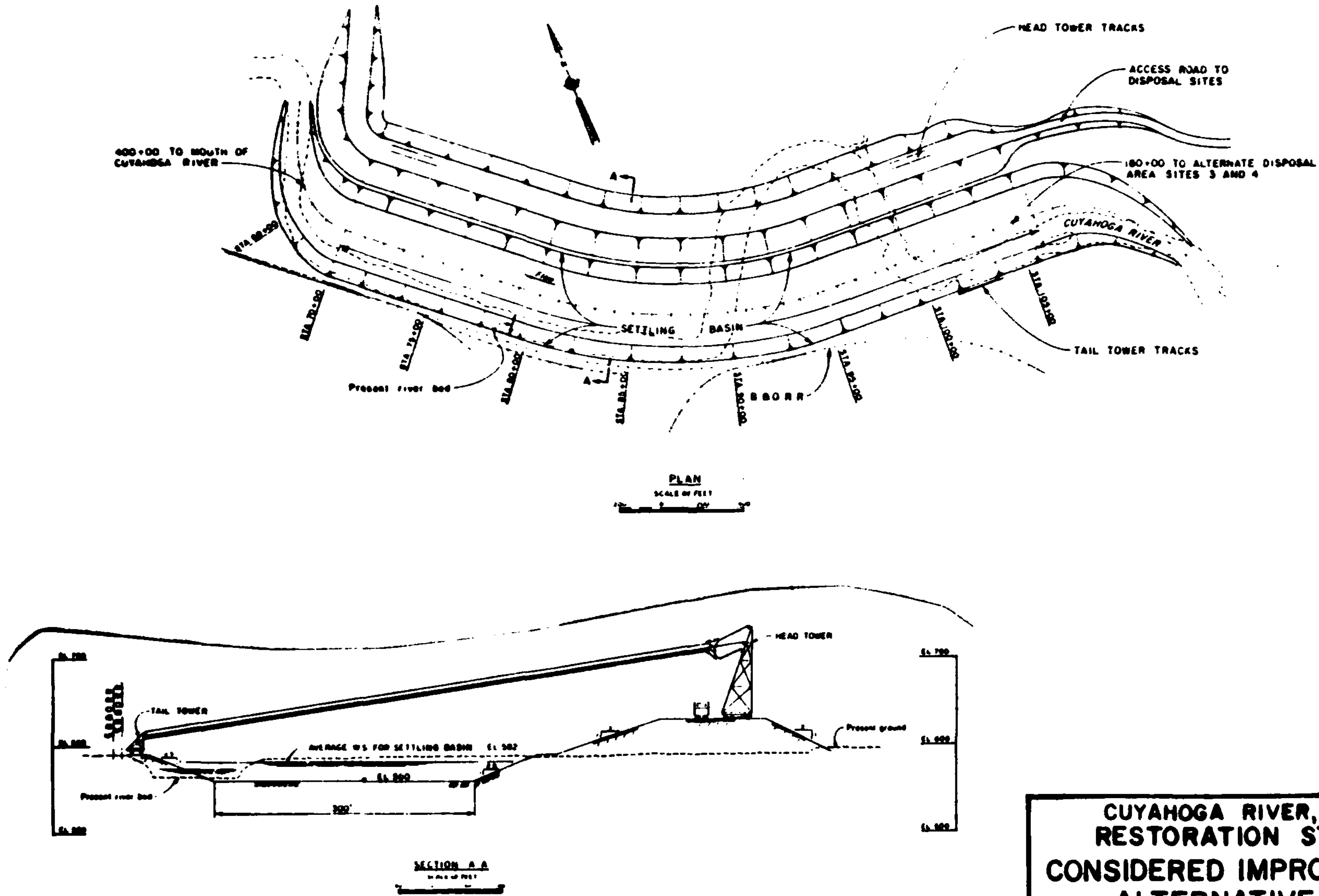
however, depended on the type of dredging operation selected. The settling basin was designed to remove 550,000 cubic yards of sediment per year (the estimated sediment load carried by the Cuyahoga River) and it was anticipated that it would operate for only 10 years.

Suitable sites for the disposal of the spoil included two landfill areas near the proposed settling basin, identified as Sites 3 and 4 on Figure 11, as well as various proposed diked disposal areas in the Cleveland Outer Harbor. Site 3 was located about 10 miles above the mouth of the Cuyahoga River. The site was previously a gravel pit, experiencing limited use, and would have held the volume of sediment that could be collected in the settling basin in about five years, i.e., 2,750,000 cubic yards, without providing dikes or other closure structures. This disposal area was accessible from the proposed settling basin via a one-mile haul road, that did not interfere with city traffic. Site 4, located approximately 1,000 feet beyond Site 3 from the settling basin, was undeveloped except for power lines passing through the area. It, too, would have held about five years of spoil from the settling basin without requiring dikes or other closure structures. Road access to Site 4 required extension of the haul road across a Cleveland thoroughfare.

There were several possible operating plans for removal and disposal of the sediment. Three considered were a Sauerman lift bucket with truck removal, hydraulic removal, and a combination of hydraulic removal with ship removal of the sediment. These three options are discussed below.

The first option investigated included a Sauerman tower cable excavating system which would have removed the sediment directly from the basin and dumped it into trucks for transportation to the landfill sites. The Sauerman facility necessitated a rectangular basin configuration approximately 4,000 feet long, with a bottom width of 300 feet. The side slopes were 1 vertical on 2.5 horizontal, and at normal river levels the depth would have been approximately 22 feet. The material obtained from the original basin excavation would have been used for a fill parallel to the basin on the right bank, thus reducing the height of the Sauerman tower installed and bringing the trucks within a more efficient distance from the loading bucket. Details of the Sauerman facility are shown on Figure 12, and the costs, as presented in the "First Interim Report" (September 1971 price levels), are shown in Table 24. From Table 24, the average cost per cubic yard of material removed for the Sauerman dredging option was $1.89 (September 1971 price levels, 5-3/8 percent interest rate and 10 year economic life).

Although the Sauerman dredging facility precluded rehandling the sediment, the nature of the settled material could have seriously reduced the effectiveness of the Sauerman System. Composite sediment samples, taken at Independence, demonstrated a grain size distribution consisting of 87 percent silt or clay. The loss of these fine particles during the lift of 22 feet through the overlying water was expected to be significant, resulting in the possible transportation of large volumes of water with the spoil.



CUYAHOGA RIVER, OHIO
RESTORATION STUDY

CONSIDERED IMPROVEMENTS
ALTERNATIVE #3
SAUERMAN DREDGING OPTION

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979

FIGURE 12

Table 24 - Estimate of First Cost and Average Annual Charges for Alternative Plan No. 3: Sauerman Dredging Option 1/

First Cost 2/	
Item	First Cost
	$
Settlement Basin: Site #8	
Lands	900,000
Excavation and Dikes	2,427,000
Sauerman System	1,106,000
Disposal Site #3	
Lands	240,000
Construction	75,000
Disposal Site #4	
Lands	300,000
Construction	225,000
Subtotal	5,273,000
Engineering and Design	192,000
Supervision and Administration	228,000
Total	5,693,000
Salvage Value	-250,000
First Cost Less Salvage	5,443,000
Average Annual Cost 3/	
Interest, \$5,443,000 @ 5-3/8%	293,000
Amortization, 10-year life @ 5-3/8%	425,000
Truck Haul, 550, 000 c.y. @ \$0.38	209,000
Dredging, Operation and Maintenance 550,000 c.y. @ \$0.20	110,000
Total	1,037,000 4/

1/ As proposed in the "First Interim Report" for the Cuyahoga River Restoration Study.

2/ September 1971 price levels.

3/ Based on September 1971 price levels, 5-3/8 percent interest rate and a 10-year economic life.

4/ Average cost per cubic yard removed - \$1.89.

The second option investigated included hydraulic removal and transportation of the spoil to disposal Sites 3 and 4. The transmission pipes associated with this plan would have required easements similar to those required for haul roads, with the advantage of burying the pipes beneath the street separating the two disposal areas. This option also precluded rehandling the spoil. The costs of this option, as presented in the "First Interim Report" (September 1971 price levels), are shown in Table 25. From Table 25, the average cost per cubic yard of material removed for the hydraulic removal and transportation option was $1.75 (September 1971 price levels, 5-3/8 percent interest rate and 10-year economic life).

The third option investigated provided for the hydraulic pumping of the spoil from the settling basin to the head of navigation, where it would have been transferred to a waterborne vessel and transported to one of several proposed diked disposal areas in the Cleveland Outer Harbor. Final selection of the harbor disposal site would have depended on minimization of adverse environmental impacts. The difficulties of pumping the material, and the cost and operation of the large vessels required, made this alternative undesirable and it was eliminated from further consideration.

The cost of dredging sediment from Cleveland Harbor and disposing of it in the existing (1971) diked disposal areas was $4.66 per cubic yard (1971). This cost was greater than the $1.89 per cubic yard average annual cost for the Sauerman dredging option and the $1.75 per cubic yard average annual cost for the hydraulic removal and transportation option (based on September 1971 price levels, 5-3/8 percent interest rate and a 10-year economic life). It was therefore concluded that a settling basin on the Cuyahoga River was economically feasible.

c. Reevaluation of Alternative Plan No. 3 - The economic feasibility of Alternative Plan No. 3 was dependent on the close proximity of spoil disposal sites 3 and 4 (see Figure 11). Subsequent to the completion of the "First Interim Report" these possible disposal sites were developed and are no longer available for use. Site 3 was partially filled and the site was used for an electrical substation of the Cleveland Electric Illuminating Company with associated electrical transmission lines and towers. Site 4 is currently being developed as an industrial park.

Since disposal Sites 3 and 4 were no longer available, a field survey was conducted to locate alternate disposal sites which had a minimum storage capacity of five years (2,750,000 cubic yards). The only site that was identified in this field survey was a gravel pit at river mile 16 on the Cuyahoga River (identifiable nonpoint source of erosion Site 16-1 - see Plate A3.31 in Appendix I). This gravel pit, however, is currently active and its acquisition price would jeopardize the economic feasibility of this alternative. In addition, this site is located approximately eight miles south of the proposed settling basin whereas Sites 3 and 4 were located within one mile of the proposed settling basin. This increased haul distance (seven miles) would significantly increase the annual cost for hauling the dredged material (approximately 600 percent) and would further jeopardize the economic feasibility of this alternative. Relocating the proposed settling basin near this gravel pit would also not be feasible since the settling basin would then be

Table 25 - Estimate of First Cost and Average Annual Charges for Alternative Plan No. 3: Hydraulic Removal and Transportation Option 1/

Item	First Cost
First Cost 2/	
	$
Settlement Basin: Site #8	
Lands	800,000
Excavation	1,440,000
Hydraulic System	790,000
Disposal Site #3 and #4	
Lands	540,000
Construction	249,000
Subtotal	3,819,000
Engineering and Design	148,000
Supervision and Administration	173,000
Total	4,140,000
Average Annual Cost 3/	
Interest, $4,104,000 @ 5-3/8%	223,000
Amortization, 10-year life @ 5-3/8%	323,000
Dredging, Operation and Maintenance for 550,000 c.y. @ $0.76	419,000
Total	965,000 4/

1/ As proposed in the "First Interim Report" for the Cuyahoga River Restoration Study.

2/ September 1971 price levels.

3/ Based on September 1971 price levels, 5-3/8 percent interest rate and a 10-year economic life.

4/ Average cost per cubic yard removed - $1.75.

located within the Cuyahoga Valley National Recreation Area (CVNRA). During informal discussions with the National Park Service, they indicated that they would oppose this plan since it violates their management policies for administration of the CVNRA.

As previously discussed, at the 19 January 1972 public meeting conducted by the Board of Engineers for Rivers and Harbors, local interests expressed opposition to the settling basin alternative at that time. Therefore, during reevaluation of this alternative, Buffalo District requested that local interests review their previous position in light of current conditions (see Exhibits G-6, G-7, and G-8 in Appendix G). The Cleveland-Cuyahoga County Port Authority and the Three Rivers Watershed District responded that their positions remained unchanged (Exhibits G-9, G-10, and G-11). The Ohio Department of Natural Resources responded that of the three options originally investigated, the hydraulic removal and transportation option offered the most promise but they did not indicate whether or not they would support this option (Exhibit G-12).

d. Conclusion - Because the original spoil disposal sites for dredged material (Sites 3 and 4) are no longer available, and no economically feasible alternate disposal site was identified in this preliminary feasibility investigation, Alternative Plan No. 3 will be eliminated from further consideration. In addition, local interests have expressed continued opposition to this alternative.

24. ALTERNATIVE PLAN NO. 4 (NO ACTION (DO NOTHING) PLAN)

The "no action" or "do nothing" plan represents the base condition for evaluation of the three structural and nonstructural alternatives previously described. This alternative, although not favored by local interests, avoids the monetary investments associated with the structural and nonstructural improvements. However, the plan would not meet the planning objective of controlling streambank erosion. Problems stated earlier in this report would also remain unchanged.

Although the "no action" or "do nothing" plan would not meet the planning objective of controlling streambank erosion, no other streambank erosion control alternative investigated for this report was economically feasible. Therefore, unless there are overriding considerations of environmental quality or social impacts warranting a departure from economic (cost-effective) decisions, the recommendation of this report will be Alternative Plan No. 4 (No Action (Do Nothing) Plan).

25. ENVIRONMENTAL FEATURES/ASSESSMENT OF ALTERNATIVE PLANS NO. 1, 2, AND 3

As a result of in-depth visual inspection of the Cuyahoga River Valley and river bottom by Corps of Engineers personnel and in-house analysis of the project, it has been determined that no overriding environmental or social benefits would be derived from implementation of any of the streambank erosion alternatives investigated for this report. Therefore, the recommendation of this report is Alternative Plan No. 4 (No Action (Do Nothing) Plan).

Engineering Regulation 200-2-2, paragraph 7b(1) states "Feasibility studies, in which either the selected plan falls entirely within the authority of another Federal agency, or the study does not result in recommendations for Corps implementation, do not require an Environmental Assessment." (underline added) Therefore, an environmental assessment was not prepared for this Preliminary Feasibility Report.

26. MANAGEMENT PROGRAMS FOR DIFFUSE NONPOINT SOURCES OF EROSION

As previously discussed, management programs to control sheet and rill erosion (diffuse nonpoint sources) were developed for each of the five subwatersheds studied for this report (Mud Brook, Tinkers Creek, Chippewa Creek, Furnace Run, and the local drainage of the Cuyahoga River). A summary description of these management programs and the associated economic evaluation, conducted to determine if further Federal involvement in upland erosion control is warranted, follows. A detailed description of each management program is presented in Appendix C - "Formulation of Erosion Control Alternatives" and Appendix D "Economic Evaluation" presents the detailed economic evaluation associated with the programs. (Note: Management programs for Brandywine Creek and Yellow Creek subwatersheds (diffuse nonpoint sources of erosion) and for the 36 identifiable nonpoint sources of erosion (gully erosion on disturbed areas) will be developed during Stage 3 planning if the recommendation of this report is to continue into Stage 3).

a. Summary Description of Management Programs Formulated to Control Diffuse Nonpoint Sources of Erosion - As previously discussed, sheet and rill erosion (diffuse nonpoint sources) from critically eroding areas in the five subwatersheds studied for this report produce approximately 850,000 tons of sediment annually (see Table 14). These critically eroding areas occur on only 24,000 acres, or 16 percent of the total area. In addition, it is estimated that of the 850,000 tons of sediment produced from these critically eroding areas, 530,000 tons is delivered to the Cuyahoga River annually and requires maintenance dredging at Cleveland Harbor. This volume of sediment accounts for 41 percent of the total volume of sediment annually dredged. Therefore, the main objective considered in developing the management programs described below, was to control the sheet and rill erosion occurring on the critically eroding areas in these five subwatersheds and thus prevent the introduction of the resultant sediment load into the river system.

The management programs that were developed for each subwatershed were composed of various combinations of Best Management Practices (BMP's). Implementation of these BMP's will reduce the existing rate of sheet and rill erosion on critically eroding areas (16 percent of the total area) to within the tolerable soil loss value (three to five tons per acre per year). It is estimated that this will result in reducing the annual volume of sediment produced from these areas by 90 percent, or 765,000 tons.

The total quantity of each BMP required to control sheet and rill erosion on critically eroding areas is summarized in Table 26 for all five subwatersheds. Selection of these BMP's was based on the existing land use of the critically eroding area. For example, from Table 15 (Summary of Critical

Erosion Areas by Land Use), a total of 750 acres of critically eroding cropland was identified in the five subwatersheds studied. Therefore, 750 acres of the BMP - conservation cropping system was specified.

As shown on Table 26, the major BMP's recommended are woodland site preparation and woodland improvement. These BMP's are required to control the sheet and rill erosion in woodland areas which, as previously discussed, produce about 66 percent of the total sediment load from sheet and rill erosion. Another major BMP recommended use was critical area stabilization. This BMP was specified for all land uses except woodland, cropland, and pastureland.

Table 27 presents a summary of the estimated first cost of the management programs developed for this report. As indicated, the total first cost for all five subwatersheds is $7,200,000. Since these management programs will only be implemented on critically eroding areas (24,000 acres), the average cost to implement these programs is $300 per acre.

b. Economic Evaluation - As previously discussed, sheet and rill erosion on critically eroding areas in the five subwatersheds studied for this report produce about 350,000 cubic yards of sediment that requires annual maintenance dredging at Cleveland Harbor. If the management programs formulated for these eroding areas are implemented, it is estimated that 90 percent, or 315,000 cubic yards, of the existing volume of sediment produced from sheet and rill erosion will be controlled.

Based on the current contract price for dredging the Cuyahoga River navigation channel of $6.15 per cubic yard, the average annual benefit that would be realized by the Federal Government for reduced dredging requirements at Cleveland Harbor is $6.15 per cubic yard X 315,000 cubic yards controlled, or $1,937,000 per year. Since average annual benefits of similar magnitude can be expected from implementation of management programs to control sheet and rill erosion in Brandywine Creek and Yellow Creek subwatersheds and gully erosion on identifiable nonpoint sources of erosion, and since the total cost of continued Federal involvement in the upland area is only $55,000 (see Section F of the Main Report - "Study Management"), it is readily apparent that continued Federal involvement in the upland area is economically justified.

(Note: The above discussion does not consider the additional savings that would be realized by the Federal Government for reduced diked disposal capacity required to contain maintenance dredging at Cleveland Harbor. Since a significant benefit would be realized for reduced dredging costs alone, it was not necessary to estimate this additional benefit to economically justify continued Federal involvement in the upland area.)

Table 26 - Summary of BMP's Required to Control Sheet and Rill Erosion from Critically Eroding Areas in the Upland Study Area [1/]

Required Best Management Practice	Unit	Quantity
Critical Area Stabilization	Acres	7,610
Conservation Cropping System	Acres	750
Pasture & Hayland Planting	Acres	206
Heavy Use Area Protection	Acres	91
Woodland Site Preparation	Acres	15,319
Tree Planting	Acres	15,319
Woodland Improvement	Acres	44
Runoff Diversion	Feet	9,700
Grassed Waterway	Acres	14
Grade Stabilization Structure	Each	0
Sediment Basin	Each	28

[1/] Does not include BMP's required to control sheet and rill erosion in Brandywine and Yellow Creek Subwatersheds.

Table 27 - Summary of Recommended Management Programs for the Upland Study Area: Estimated First Cost and Annual Operation and Maintenance Cost 1/

Subwatershed	First Cost of 2/ Construction	Annual Operation 2/ and Maintenance Cost
	$	$
Mud Brook	385,380	5,265
Tinkers Creek	1,782,990	33,851
Chippewa Creek	632,095	12,199
Furnace Run	768,504	8,795
Local Drainage	3,671,778	35,379
Total	7,180,747	95,489
	Say 7,200,000	Say 95,000

1/ Does not include Management Programs for Brandywine Creek and Yellow Creek Subwatersheds.

2/ Cost estimate based on SCS experience with similar type projects with unit costs updated to November 1979 price levels.

SECTION E
COMPARISON OF PLANS

The purpose of this section is to compare the alternative plans of improvement formulated to control streambank erosion in terms of their contributions to four accounts: National Economic Development, Environmental Quality, Regional Development, and Social Well-Being. The basis of comparison for the alternative plans is the no action (do-nothing) plan. However, since the recommendation of this report is the no action (do-nothing) plan, this section was not required for this Preliminary Feasibility Report.

SECTION F
STUDY MANAGEMENT

The purpose of this section is to inform the reader of this report of the principle activities required to complete the Erosion and Sedimentation Study.

27. REQUIRED ACTIVITIES TO COMPLETE THE EROSION AND SEDIMENTATION STUDY

The plan of study presented herein assumes: (1) the recommended plan of this Preliminary Feasibility Report for controlling streambank erosion is Alternative Plan No. 4 (No Action (Do-Nothing) Plan), and therefore, the Third Interim Study will be terminated; and (2) the Corps of Engineers will complete the remaining upland erosion studies and document the results in a Supplemental Information Report. Based on these assumptions, the Study Flow Network (CPM) presented in Appendix H (Figure H-1) was developed. With reference to this CPM the remaining major activities to be completed are as follows:

a. Public Coordination - This Preliminary Feasibility Report will be provided to Federal and State agencies, local and regional officials, and the general public for their review and comment. Following the review and comment period, the Buffalo District will issue a Termination Report in order to terminate the Third Interim Study.

b. Complete Upland Erosion Studies - The following upland erosion studies will be completed: (1) diffuse nonpoint source erosion studies for Brandywine Creek and Yellow Creek Subwatersheds including development of management programs to control sheet and rill erosion on critically eroding areas identified in these two subwatersheds; and (2) quantifying the identifiable nonpoint sources of erosion and developing management programs to control this erosion. The results of these additional studies will be documented in a Supplemental Information Report. The total study cost for this program is $55,000.

SECTION G
CONCLUSIONS

The purpose of this section is to briefly summarize the results of this preliminary feasibility investigation. The section presents information on the results of the streambank erosion control studies; the results of the upland erosion control studies; and the policy issues for which review and guidance was requested.

28. SUMMARY RESULTS OF STREAMBANK EROSION CONTROL STUDIES

The purposes of the streambank erosion control studies conducted for this Preliminary Feasibility Report were to identify and quantify sources of streambank erosion and to determine the feasibility of implementing streambank erosion control measures in the channel component study area. The channel component study area consisted of the main stem (main channel) of the Cuyahoga River between Independence, OH (river mile 13.8) and Old Portage (river mile 40.25) and the channels of the six major tributaries in this reach. These tributaries are Mud Brook, Brandywine Creek, and Tinkers Creek on the east side of the basin and Yellow Creek, Furnace Run and Chippewa Creek on the west side of the basins.

Results of the studies conducted for this report indicated that of the 143 miles of streambanks studied (71.5 river/stream miles) only 22.7 miles, or 16 percent of the streambanks were actively eroding. The studies also indicated that annual streambank erosion annually produces about 52,000 cubic yards of sediment. Of this 52,000 cubic yards of sediment, it is estimated that 47,000 cubic yards is transported to Cleveland Harbor and requires annual maintenance dredging. This volume of sediment represents about 5 percent of the total volume of sediment annually dredged. The studies also indicated that there were seven locations on the Cuyahoga River where the existing rate of annual streambank erosion was likely to produce a change in the course of the river (potential meander change). If these potential meander changes were to occur, they would introduce an additional 125,000 cubic yards of sediment into the river system. In addition, the studies indicated that damage to local roads and railroad facilities of the Baltimore and Ohio Railroad will occur in the future due to streambank erosion at these sites.

Initially a total of nine structural and/or nonstructural conceptual alternatives (including no action) were formulated to control streambank erosion within the study area. Preliminary evaluation and assessment of these conceptual alternatives indicated that only three alternatives warranted further consideration. In addition, the basis of comparison for these three alternatives was the no action (do nothing) plan. Based on additional evaluation and assessment, it was determined that the three alternatives warranting further study were not economically feasible and no overriding environmental or social benefits would be derived from implementation of these plans. Therefore, it is concluded that the "no action" plan is the appropriate course of action as regards streambank erosion control for the Cuyahoga River and its tributaries. In addition, it is concluded that the Third Interim Study should be terminated.

29. SUMMARY RESULTS OF UPLAND EROSION CONTROL STUDIES

The purposes of the upland erosion control studies conducted for this *Preliminary Feasibility Report* were to identify and quantify sources of upland erosion and to develop a series of management programs to control erosion in the upland study area (the 303 square-mile drainage basin of the Cuyahoga River between Independence (river mile 13.8) and Old Portage (river mile 40.25). Implementation of these management programs, must, however, be pursued by other (local) interests.

Results of the studies conducted for this report indicated that erosion and sedimentation is a very serious problem in the upland area. For example, sheet and rill erosion (diffuse nonpoint sources) from critically eroding areas in the five subwatersheds studied for this report produce about 850,000 tons of sediment annually. These critically eroding areas occur on only 24,000 acres, or 16 percent of the total area. All other areas within the five subwatersheds produce an insignificant volume of sediment and can be deleted from further consideration.

Of the 850,000 tons of sediment produced from critically eroding areas in the five subwatersheds studied for this report, it is estimated that 530,000 tons is delivered to the Cuyahoga River system annually and requires maintenance dredging at Cleveland Harbor. This volume of sediment represents about 41 percent of the total volume of sediment dredged. Therefore, in order to significantly reduce dredging costs at Cleveland Harbor, an effective erosion control program must be implemented on these critically eroding areas.

Management programs were developed to control sheet and rill erosion on critically eroding areas for the five subwatersheds studied for this report. These management programs consisted of Best Management Practices (BMP's) which, based on Soil Conservation Service experience with similar type projects, are both effective in erosion control and economically justified (that is, local interests implementing the management programs will realize benefits equal to or greater than the cost of implementing these programs). The average cost to implement these management programs on critically eroding areas was estimated at $300 per acre.

30. POLICY ISSUES TO BE RESOLVED

Because of the significant monetary benefits that would accrue to the Federal Government from implementation of the management programs developed to control upland erosion (as indicated by potential reduced dredging requirements at Cleveland Harbor) the Buffalo District recommended that the Corps of Engineers provide technical assistance to local interests in implementing these plans. This technical assistance would have been provided through an Interagency Agreement with the Soil Conservation Service. In addition, to ensure continuous funding of this Interagency Agreement, it was recommended that funds for this program be provided from the operation and maintenance budget for Cleveland Harbor. Review of and approval for these proposed actions was requested when the Preliminary Feasibility Report (November 1979) was coordinated with North Central Division and Office, Chief of Engineers. As a result of this review, it was concluded that the Corps of Engineers did not have adequate authority to implement the proposed technical assistance program and that the Buffalo District's recommendation to provide this assistance be deleted from the report. The Corps can, however, provide technical assistance to non-Federal public interests in developing methods of preventing damages attributable to streambank erosion under authority of Section 55 of Public Law 93-251 (Streambank Erosion Control Evaluation and Demonstration Act of 1974, as amended).

SECTION H
RECOMMENDATIONS

Since streambank erosion control improvements cannot be economically justfied, it is recommended that no further consideration be given to streambank erosion control improvements on the Cuyahoga River Basin and that, therefore, the Third Interim Study on Erosion and Sedimentation be terminated. In addition, it is recommended that local interests implement upland erosion control practices (Best Management Practices) on critically eroding areas in the watershed. To assist in this effort and because of the significant monetary benefits that would accrue to the Federal Government from implementation of plans to control upland erosion, it is further recommended that the District complete the remaining upland erosion control studies through the existing Interagency Agreement with the Soil Conservation Service. The results of these additional studies will be documented in a Supplemental Information Report.

Studies conducted for this report identified sites where damage to local roads and railroad facilities of the Baltimore and Ohio Railroad will occur in the future due to streambank erosion. It is recommended that the affected interests (local governments and the Baltimore and Ohio Railroad) implement streambank erosion control measures at these sites before this damage occurs and service is interrupted. It is noted that, prior to construction of these protective measures, affected interests must make application for a Department of the Army Permit if filling of the waterway or flood plain is proposed.

GEORGE P. JOHNSON
Colonel, Corps of Engineers
Commanding

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